Conceptual approaches to the development of safe food products based on rabbit breeding resources and plant composites

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Abstract. The purpose of the work was to develop technologies for functional meat products, namely cooked and smoked sausages using the resources of the rabbit breeding industry and plant-based enriching additives. The conducted studies allow us to recommend using a rational dose of a complex protein-carbohydrate composition in the development of a new type of cooked-smoked sausage in the amount of 10%. It contributes to improving the functional properties of minced meat, due to the strong cross-linking of proteins of transglutaminase enzymes and as a result, a positive effect on the consistency of the product (increased elasticity, without the formation of voids). The chemical composition of cooked-smoked sausage of enriched composition was studied and the positive effect of introduced protein-carbohydrate composites on its quality indicators was established. Economic calculations have confirmed the feasibility of implementing the developed technologies in production, and the totality of the estimated indicators proves the real possibilities and feasibility of using regional meat and plant resources on the principles of resource conservation and self-sufficiency.

1. Introduction

Due to the increased technogenic load on the human body, there is a need to develop food products that can have a positive effect on the body metabolism [3, 4]. The conceptual approach in the field of healthy nutrition of the population is based on the theory of the quality of life as an element of social development of the model of society. The concept implemented by this approach is a system of interrelated views on healthy food products, including functional ones, including scientifically based food components, minimum consumption standards and scientifically based healthy food products for the physical reproduction of the population. This concept is based on the fundamental theory of V. I. Vernadsky about the biosphere and noosphere, which reveals the relationship and unity of the planet population with nature.

Of particular interest is the change in prescription formulations of food products (reducing the total fat content, especially animal sources of cholesterol and saturated fatty acids-sources of TRANS-isomer acids, as well as reducing the content or complete replacement of sugar and enrichment with physiologically functional ingredients), which is the most promising at the current level of technology development [1, 5, 6-8].

A significant role in this aspect is played by functional meat products that have a high nutritional and biological value, due to the use of composite mixtures rich in dietary fibers.
It should be noted that the proposed enrichment of food meat systems is associated with a persistent lack of PV in the daily diet of modern humans, which in turn contributes to an increase in diseases of diabetes, atherosclerosis, coronary heart disease, gastrointestinal diseases, as well as various malignancies [3]. Therefore, the creation of recipes and technologies for FPP based on meat and complementary foods with a focus on reducing stress, increasing nutritional value, normalizing lipid metabolism and gastrointestinal activity, by enriching them with components with a functional focus, is timely and relevant. In this connection, the purpose of the work was to develop approaches to the creation of meat systems, in particular, cooked – smoked sausages using a composite mixture of a complex composition of protein-carbohydrate nature.

2. Materials and methods
Experimental studies were conducted in the conditions of research laboratories of the Voronezh State Agrarian University named after Emperor Peter I and the Voronezh State Agrarian University of Engineering Technologies (Voronezh). The goods were produced at the facilities of FE "Kuzmichev", Voronezh. Evaluation of physical, chemical and organoleptic parameters of combined products was performed using standard methods [2]. As research objects, we used hand-boned rabbit meat, semi-fat veined pork according to GOST R 53221-2008, veined beef according to GOST R 54315-2011, PCC (protein-carbohydrate composition) based on Jerusalem artichoke dietary fibers, lupine flour from lupine seeds modified by germination, beef protein "Vitegra Beef Neutral" and the enzyme preparation (TG) transglutaminase "REVADA TG 11" (BDF Natural ingredients, S. L., Spain). Minced cooked-smoked sausage "Delicatessen" (control) was used as the basis for the control function. We studied the functional and technological properties of model minced meat based on rabbit meat and stringed pork with the introduction of PCC in the amount of 0-12% by weight of minced meat.

3. Results and Discussion
When creating food recipes, one should come not only from the standpoint of economy used in the production of food system resources, but also from the potential of obtaining biologically high-grade food, promoting metabolism and protective functions of the organism with simultaneous filling up of essential body nutrients, which finds reflection in the modern science of nutrition.

It is known that the production of functional products is included in the program of state measures aimed at promoting a healthy lifestyle of modern people and plays a special role in improving the structure of food rations. Most of the food products produced by the food industry, including the meat industry, do not meet the requirements for quality and safety criteria, which largely requires the development of fundamentally new approaches to their creation by using protein-carbohydrate compositions containing the necessary nutrients.

It should be noted that introduction of various types of fortifiers into food systems based on meat allows obtaining products of a combined composition that do not always meet the process requirements. This in turn causes the need to introduce an increased content of plant additives that negatively affect not only the functional and process properties, the structure of the product, but also sanitary and hygienic standards. One of the approaches to solving this problem can be the use of functional products in the technology of protein-carbohydrate composite mixtures containing high-grade proteins, dietary fibers and minerals. As a structure-forming component, it is promising to use the transglutaminase enzyme, which has the ability to cross-link the protein framework into a strong matrix and positively affects the structure and output of the final product at relatively small dosages.

The protein – carbohydrate composition (PCC) developed by us using mathematical modeling methods on the basis of Jerusalem artichoke dietary fibers, lupine flour from lupine seeds modified by germination, beef protein "Vitegra Beef Neutral" and the proposed enzyme preparation has a high moisture-binding capacity-450 %, which is comparable to the moisture-binding capacity (MBC) of soy protein isolates. The fat-binding capacity (FBC) is 280 %. It is proved that the addition of composite PCC to minced meat in an amount of 10% improves its moisture-binding (MBS), moisture-retaining (MRC) and fat-binding (FBS) abilities of minced systems (Figure 1). The research made it possible to
develop a recipe for boiled and smoked sausage based on the resources of the "Novozadonskaya" rabbit breed.

![Figure 1](image1.png)

**Figure 1.** Functional and process properties of model minced systems with the introduction of complex PCC

Table 1 shows the data that allow us to determine the daily human need for amino acids when using cooked-smoked sausage "Novozadonskaya", enriched with a composite PHK that provides the consumer with the necessary amino acids. From the presented data, it can be seen that the consumption of 100 grams of cooked-smoked sausage can satisfy the human body with all amino acids by 8.67 – 45.60 %, with the exception of methionine+cystine – 147.77%.

The results of complex physical and chemical studies have shown (Table 2) that the prototype of a cooked-smoked sausage product (figure 2), developed with the addition of PCC, has an increased nutritional and biological value. The organoleptic evaluation conducted by the tasting Commission showed that the prototype had a higher score - 8.6 points, against the control sample-7.8 points.

![Figure 2](image2.png)

**Figure 2.** Experimental samples of cooked-smoked sausages: 1-cooked-smoked sausage "Delicatesnaya", 2-cooked-smoked sausage «Novozadonskaya»
Table 1. The satisfaction of daily needs of amino acids when consuming cooked-smoked sausages “Novozadonskaya”

| Name of the physiologically functional ingredient | The daily requirement according to MR 2.3.1.19150 | Cooked-smoked sausage «Novozadonskaya» (per 100 g of product) | Providing the daily requirement, % of the norm when using 100 g |
|------------------------------------------------|-------------------------------------------------|---------------------------------------------------------------|-------------------------------------------------------------|
| Essential amino acids, g / 100 g:                |                                                 |                                                               |                                                             |
| valine                                          | 2.50                                            | 1.14                                                         | 45.60                                                       |
| isoleucine                                      | 2.00                                            | 0.87                                                         | 43.50                                                       |
| leucine                                         | 4.60                                            | 1.34                                                         | 29.13                                                       |
| lysine                                          | 4.10                                            | 1.54                                                         | 37.56                                                       |
| threonine                                       | 2.40                                            | 0.89                                                         | 37.08                                                       |
| tryptophan                                      | 0.80                                            | 0.25                                                         | 31.25                                                       |
| Phenylalanine+tyrosine                         | 4.40                                            | 2.89                                                         | 65.68                                                       |
| Methionine+cystine                              | 1.80                                            | 2.66                                                         | 147.77                                                      |
| histidine                                       | 2.10                                            | 0.98                                                         | 46.66                                                       |
| Interchangeable amino acids, g / 100 g:         |                                                 |                                                               |                                                             |
| alanine                                         | 6.60                                            | 1.14                                                         | 17.27                                                       |
| arginine                                        | 6.10                                            | 1.32                                                         | 21.64                                                       |
| aspartic acid+asparagine                        | 12.20                                           | 2.42                                                         | 19.83                                                       |
| glycine                                         | 3.50                                            | 0.98                                                         | 28.00                                                       |
| glutamic acid+glutamine                         | 13.60                                           | 2.86                                                         | 21.03                                                       |
| proline                                         | 4.50                                            | 0.47                                                         | 10.44                                                       |
| serine                                          | 8.30                                            | 0.72                                                         | 8.67                                                        |

Table 2. Physical and chemical indicators of the developed cooked and smoked sausage products

| Name of the indicator                              | "Delicatesnaya" (control) | «Novozadonskaya» (experience) |
|---------------------------------------------------|---------------------------|-------------------------------|
| Mass fraction of moisture, % max                  | 51.00                     | 51.44                         |
| Mass fraction of protein, % min                   | 18.50                     | 22.56                         |
| Mass fraction of fat, % max                       | 30.50                     | 20.80                         |
| Mass fraction of sodium chloride, % max           | 4.00                      | 3.80                          |
| Mass fraction of sodium nitrate, % max            | -                         | 0.005                         |
| Mass fraction of dietary fiber, %                 | -                         | 5.20                          |

Experimental determination of the relative biological value of cooked-smoked sausages was performed using microscopic infusoria Tetrachymena pyrphormis. A comparative characteristic of the growth of the test organism in the studied objects is shown in figure 3.

It was found that the most abundant microbial growth was observed in developed a new form of boiled-smoked sausage "Novosadska" in comparison with the control sample sausages. It was found that the most abundant microbial growth was observed in the developed new form of boiled-smoked sausage "Novosadskaya" in comparison with the control sample sausages. The calculation of Tetrachymena pyrphormis in the Goryaev counting chamber showed that the high index of the relative biological value of the product developed by us (144.27%) in comparison with the control (91.45%) is due to a higher balance of the amino acid composition.
Figure 3. Comparative characteristics of growth intensity of *Tetrachymena pyriformis*: 1-cooked-smoked sausage «Novozadonskaya», 2 - control («Delicatesnaya»)

Thus, the introduction of a protein-carbohydrate complex into the composition of minced meat indicates the feasibility of using it as an ingredient for creating functional products.

Figure 4. Scheme of continuous improvement in the quality management system of sausage products

The state registration system applies to food products. According to article 10 of TR CU 021/2011, the production of food products must be subject to the mandatory application of a control system based on the principles of HACCP, which is regulated in GOST R ISO 22000-2019 *Food safety management Systems. Requirements for organizations involved in the food production chain*, GOST R 51705.1-2001 *Quality Systems. Food quality management based on HACCP principles. General requirements*. The introduction of HACCP principles gives high results in ensuring the quality of manufactured products of the traditional range and is promising in the development of a quality management system for managing the quality of complex food products using various fortifiers, including protein-carbohydrate nature (figure 4). Based on the analysis of the process approach, the results of experimental studies and theoretical positions in product quality control, applied the scheme of continuous improvement of the
quality management system for sausages, which has such features for the action as "goal-setting", "problem", "study problems", "problem analysis".

The conducted economic calculations show that the level of profitability of production of cooked and smoked sausages "Novozadonskaya" is 49.15% (the control recipe is 31.40%). The production of 1000 kg of products will allow you to make a profit of 235,656.47 rubles, respectively.

4. Conclusion
The conducted studies allows us to recommend using a rational dose of a complex protein-carbohydrate composition in the development of a new type of cooked-smoked sausage in the amount of 10%. It contributes to improving the functional properties of minced meat, due to the strong cross-linking of proteins of transglutaminase enzymes and as a result, a positive effect on the consistency of the product (increased elasticity, without the formation of voids). Economic calculations have confirmed the feasibility of implementing the developed technologies in production, and the totality of the estimated indicators proves the real possibilities and feasibility of using regional meat and plant resources on the principles of resource conservation and self-sufficiency.

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