

Plant ingredients in the formulation of meat products: review

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Abstract

The use of plant ingredients is widespread in the technology of production of meat products. Replacement of the main raw material (minced meat) with a plant component in the production process is primarily to reduce the cost of the product, and secondly, to give the meat product specific taste qualities and improve the functional and technological properties. In the article the methods of production of meat products (minced meat, sausages, pates, cutlets, etc.) with the addition of a plant ingredients are considered. Production of meat products with the use of ingredients of both animal and plant origin not only expands the range of products, but also promotes the rational use of raw material resources, providing the population with quality food products. Plant raw ingredients give new dietary properties to the product, increase biological value, improve organoleptic indicators of finished products, reduce its cost. Plant additives introduced into the formulation of meat products enrich with plant protein, dietary fiber, minerals, vitamins and other biologically active components.

Key words: meat product, plant ingredient, enrichment, nutrients, method of production

Introduction

Plant foods are a significant part of the human diet. Plant products provide the only natural sources of starch, non-starch polysaccharides, vitamins C and E, β -carotene, bioflavonoids, as well as the main sources of polyunsaturated fatty acids, potassium, magnesium, manganese, nickel [1, 2]. Therefore, a perspective direction is the combination of meat and plant raw materials to increase the nutritional value of the product. Plant proteins are used to reduce the cost of producing meat products. However, plant proteins can be used to increase the nutritional value of products if high-quality vegetable raw materials

are used. Plant proteins of soybean, sunflower, wheat, corn, cotton, oats, barely contain various substances beneficial to the body [3, 4].

At the present time, the problem of improving the technology and broadening the assortment of meat products is of particular importance. For meat processors, an important task is to find new technological solutions related to meat processing and to introduce modern methods of using food ingredients at the enterprises. Developed products must not only satisfy the consumer with a balanced nutritional value, but also meet the organoleptic characteristics of traditional poultry, beef, pork products [5, 6, 7].

Production of combined semi-finished products using animal and plant proteins not only expands the range of products, but also promotes rational use of food resources, providing the population with quality food products. [8, 9]. Improving the recipes of meat products by enriching them with vegetable raw materials can improve the population' diet, making it more nutritious and balanced [10, 11].

The purpose of this work is to review the recipes and technologies for the production of meat products with the addition of vegetable ingredients to improve the nutritional and biological value.

Meat semi-finished products with the addition of plant ingredients

The formulation of semi-finished meat products that involve the replacement of animal ingredients with vegetable additives is a perspective way to solve the problem of increasing the availability of meat products, expanding their assortment and increasing their nutritional value.

Researchers at East Siberian State University have proposed a method for the preparation of cutlets, providing standard steps for the production of chopped semi-finished products, but differing in use of yak meat as the main ingredient. When preparing the ground meat is added protein-carbohydrate-fat composition, which contains flour from sprouted oat grains in the amount of 7 - 8 % of the weight of the composition. Sprouted oats flour was obtained by soaking oats grains in water, germination, drying, separation of sprouts and milling. Protein-carbohydrate-fat composition is introduced into the ground meat in the quantity of 10 - 15 % by weight of meat. Yield of the ready product when using 10-15% of protein-carbohydrate-fat composition increases by 2,5-3,8% due to the use of soy isolate and flour from sprouted oats grains. Herewith, the content of iron in the products amounted to 1,68 - 1,69 %, which is higher than its content in the prototype by 52,7 - 53,6 %. The use of the claimed method allowed to increase the water-holding capacity of minced meat and the yield of the finished product, improve organoleptic indicators of cutlets, expand the range of cutlets with increased food and biological value [12].

A group of scientists [13] is developed chopped meat semi-finished product for dietary nutrition. The method of production provides the use of dietary fibers gum arabic, hydrated soy texturate, for giving prophylactic properties and improving rheological characteristics and water-binding capacity of the product. The recipe also includes beef meat, wheat flour bread, fresh onions, black pepper, salt and water.

The authors [14] proposed the technology of production of a functional product - meat and vegetable cutlets with marrow-type pumpkin which is balanced in its chemical composition, has the highest organoleptic properties and low cost. The analysis of experiments allowed to suggest the most rational version of the recipe for meat and vegetable patties with marrow-type pumpkin a variant where the content of meat raw material is 55%, vegetable raw material - marrow-type pumpkin - 12% and

semolina - 8%. The introduction of 20 % of vegetable raw materials in the recipe leads to a redistribution of mass proportions of the main macronutrients in the minced meat: an insignificant increase in the mass proportions of protein, carbohydrates and a decrease in fat content.

Slobodyanik and Uspenskaya (2009) developed canned meat based on the meat of cattle, pigs, poultry using carrots, which allows enriching these products with dietary fiber, carotene, bioflavonoids, a whole complex of B vitamins, nicotinic acid, thiamine, riboflavin, pyridoxine, pantothenic acid, folic acid, vitamin C, E, and K. Nutritional value, organoleptic and functional properties of these products allow to recommend them for children and gerodietic nutrition, nutrition of workers in hazardous conditions, in contact with xenobiotics, in conditions of high radiation, magnetic fields, in hot workshops, etc. The introduction of up to 10-15% of carrots into the composition of minced meat semi-finished and canned products reduce the energy value of the product, which is very important for the prevention of obesity, especially for the elderly people. An important role is played by increasing the level of macro- and micronutrients in the meat product due to potassium (200 mg%), calcium (51 mg%), magnesium (38 mg%), iron (1.2 mg%), copper (0.23 mg%), zinc (0.40 mg%), manganese (0.08 mg%), cobalt (18.2 mkg%) contained in carrots. [15].

Authors [16] investigated the possibility of using wheat oboin flour as a source of vegetable protein and dietary fiber in the creation of meat and lean semi-finished products. Ground meat consisted of cutlet beef and pork meat in the ratio of 1:1 and wheat flour. The studies showed that the maximum possible replacement of minced meat with wheat rim flour, which does not adversely affect the quality of the meat semi-finished product, is 18%.

Dorzheva et al. (2012) created minced lamb semi-finished products with the addition of barley flour in the recipe. The optimal quantity of barley meal in the meat mince according to the results of studies was 10% [17]. Authors [18] in the development of combined meat semi-finished products, during the study the substitution of meat for bean flour was carried out. The study found that the most acceptable variant was a recipe containing 12% bean flour.

Specialists of the All-Russian Research Institute of Meat Industry named after Gorbatov developed chopped semi-finished products based on the complex use of beef, pork and poultry meat with the addition of biologically active additives such as linseed oil, calcium mineral enrichment, as well as chickpeas, wheat fiber and natural phospholipids [19].

The method of production of chopped meat and vegetable semi-finished product is known [20], where meat from poultry, pork or their composition is used as a meat raw material. To increase biological value the authors of the work proposed to add the following biological additives to the meat semi-finished product: boiled chickpea grains, marrows, pumpkin, iodocasein, soybean isolates, soy protein or wheat fiber, flaxseed oil, as well as buckwheat and oatmeal flour. As a result, functional foods are obtained taking into account the main pathogenetic mechanisms of cardiovascular disease. Also the selection of these components provides a preventive effect (improving metabolic processes, restoration of metabolism of the vascular wall and heart muscle, anti-atherosclerotic effect), achieved by reducing energy value, table salt and cholesterol content.

Authors studied the possibility of using secondary tomato raw materials as isolate dry powder in the production of chopped meat semi-finished products. Secondary raw materials of tomatoes are

represented mainly by tomato seeds and skin. According to the researchers, the oil fraction of tomato seeds is very stable during storage and has antioxidant properties. It exhibits higher antioxidant properties when added to another fat. Tomato peels contain tomatin, which is detrimental to many pathogenic bacteria and fungi. In addition, the use of powders of tomato raw materials enriches recipes with dietary fiber [21].

Department of Food Technology and Expertise of Goods of the Moscow State University of Technology and Management named after K.G. Razumovsky proved the feasibility of using vegetable raw materials (pine nut cake, red onion extract powder, buckwheat, rice, carrots, zucchini) for the production of meat semi-finished products. The recipes for meat-vegetable semi-finished products from lamb, chicken breast with the addition of pine nut cake and red onion extract powder were developed. It was found that the pine nut cake had a positive effect on the structural and mechanical properties of meat semi-finished products [22].

Aslanov et al. studied the possibility of using the lentil protein supplement as a substitute for meat components in the production of chopped products. The conditions for obtaining the desired level of viscosity and emulsification of the system were determined. The studied minced meat had high structural and mechanical properties [23].

Methods of production of pâté, stuffing, sausages with the addition of plant ingredients

Method of obtaining minced meat includes mixing ground beef, ground fatty pork, emulsion of pork skins, eggs or melange, hydrated soy protein, vegetable additive of crushed, extruded and hydrated holosemmon pumpkin seeds, biologically active additive "Lactumin", onions, spices and water. The method allows to simplify the technology, expand the assortment of minced meat for the preparation of meat products for functional purposes, increase the biological value and organoleptic characteristics of the finished products [24].

The authors developed a production method of meat pâté with therapeutic, prophylactic and radioprotective properties. In the preparation of meat pâté as a vegetable component topinambur was used, and the components were introduced at the following ratio, mass %: beef meat - 71-73, crushed topinambur 10-12, unsalted butter 10-12, milk 2,5 % of fat content 3-5, table salt 1, ground black pepper 1 [25].

Plants are a rich source of fats (polyunsaturated fatty acids), carbohydrates, macro- and microelements, vitamins and easily digestible proteins. Large volumes and relatively low costs of their production make it possible to compensate a deficiency of biologically active ingredients in the diet of the population [26, 27].

In [28] developed functional meat products using pumpkin seed powder. The introduction of pumpkin seed powder leads to an increase in minerals, especially significantly in magnesium. Magnesium activates enzymes regulating carbohydrate, lipid, protein metabolism; storage and release in ATP; stimulates the breakdown of nucleic acids; reduces excitation in nerve cells; relaxes smooth muscles, is necessary for nerve and muscle function.

The authors [29] developed functional products based on rabbit meat using lentils. Lentils are recommended for the prevention of diabetes, digestive disorders, cancer, especially colon and breast cancer, immunity strengthening. Pregnant women should eat lentils during the whole period of pregnancy,

which has a positive effect on the formation and development of the foetus. The development of minced rabbit meat-based semi-finished products with lentils as a functional ingredient will allow to create products characterized by high nutritional and biological value and recommended for use in the diet of pregnant women, as well as a wide range of consumers.

Scientists [30] considered the possibility of using parsnip and chickpea bean powder in the composition of mixtures recommended for obtaining combined meat systems. It is shown, that adding of the developed composite mixture in quantity 3,0-3,5 % in the ratio 0,5:2,0 promotes increase of all functional and technological properties of minced meat and stabilization of quality of meat systems.

The purpose of the author [31] at the initial stage was the definition of the proportion of the pumpkin powder instead of the main raw materials, for this purpose the functional and technological properties of the model minced meat were investigated. A model stuffing with replacement of meat raw material in quantity 3%, 5%, 7%, 10% by pumpkin powder was used as a test sample, as a control sample a meat pate, produced according to the State Standard 12318-66. Pumpkin powders were added pre-hydrated with water in the ratio of 1:8. The results of the experiments show that the highest water-binding capacity was recorded in the sample with 5 % of the pumpkin powder. This is probably due to the fact that in this sample the dietary fibers contained in the pumpkin powder are able to provide the highest (maximum) moisture retention. Since the powder has fat-absorbing ability, there is a decrease in fat content.

Authors [32] patented method of production of cooked sausage with vegetable additive. The pre-prepared food additive consisting of rice flour, food gelatin, chitosan and whey, as well as an aqueous infusion of chamomile and St. John's wort is introduced. The components are taken in a certain quantitative ratio. The invention provides improvement of chemical, amino acid, mineral and vitamin composition of cooked sausage, which along with higher nutritional value, improved structural and mechanical properties, has functional and preventive properties for persons suffering from obesity. The food additive is prepared as follows: dissolve chitosan in milk whey at a temperature of 60-65 ° C. Food gelatin is added to the prepared solution and homogenized for 4 minutes, then rice flour is added and the mixture is homogenized again for 6 minutes. Then the wet additive is dried at a temperature not lower than 75 ° C to a moisture content not exceeding 8% and powdered in a crusher to a powdery state (particle size not exceeding 50 microns). Mass fraction of dry matter of food additive is 90,0 - 91,0%, active acidity, pH - 6,2-6,5. When adding it to minced meat the food additive is hydrated with water in the ratio of 1:3. Infusions of chamomile and Hypericum are prepared as follows: 0.1 kg of chamomile and Hypericum is poured over 2.0 liters of hot boiled water at 85 - 90 ° C, cover and heated in a water bath for 15 min, then cooled at room temperature (20 - 25 ° C) for 45 minutes and filtered. Aqueous infusion of chamomile and Hypericum is added in an amount of 2.6 and 1.4 liters per 100 kg of meat respectively.

Amirkhanov K.J. [33] studied the development of technology of meat product with the combined use of mutton, horse meat, topinambur, as a result of which the prophylactic product enriched with inulin was received. The optimal values of the components in the meat-based product are as follows (%): mutton - 50%, horsemeat - 40%, topinambur - 10%.

The authors [34] developed the recipe for meat-plant pates with protein concentrate from alfalfa including beef, melted beef fat, fried onions, beef bone broth, protein concentrate from alfalfa, table salt,

ground black pepper and ground cinnamon. In the experimental samples of canned meat pâté the amount of alfalfa protein concentrate was 10%. The protein concentrate from alfalfa was added to the cutter at the stage of minced meat preparation after adding the main components simultaneously with spices.

Scientists studied the possibility of using protein preparations from seed cake, tomato and safflower meal in the production of canned liver pâté. Partial replacement of meat raw materials with paste-like protein isolates from tomato seed cake and safflower meal allows to obtain a combined product of high nutritional value [35].

Thus, the use of vegetable raw materials in the manufacture of meat products can enrich the product with dietary fiber, vitamins, and minerals.

In the work [36] formulations of meat-plant pates with the addition of chickpeas, olive oil and polysaccharides are developed. The developed pates are designed for therapeutic and prophylactic nutrition of anemic patients, as well as for functional nutrition of healthy people and for nutrition in conditions of intense muscular activity (military personnel, tourists). The authors noted that the developed products are balanced in amino acid composition, the content of polyunsaturated fatty acids, which allows to produce meat products with a high therapeutic and preventive effect for the nutrition of patients with cardiovascular disease and cancer.

Nefedova N. V. has developed technologies for semi-finished meat products and cooked sausages replacing meat with carrots. Natural antioxidants present in fermented carrots - vitamins A and E prevent the development of oxidative processes. Studies have confirmed that the used additive increases the digestibility of the product, as well as promotes color stability of the finished products [37].

The Siberian Research and Design and Technological Institute of Processing of Agricultural Products developed semi-finished beef minced meat with a protein vegetable component. Germinated wheat grains were used as a protein vegetable component in an amount of 25% to the mass of minced meat. Produced meat-plant semi-finished products had a balanced chemical composition, lower production cost, high nutritional value and good organoleptic indicators [38].

The authors studied the prospects of using a lentil protein preparation as a substitute for meat in the production of meat products [39]. The functional properties in protein-water system were investigated by using mathematical methods of planning experiments. The experimental minced meat products containing lentil protein preparation have high rheological and structural-mechanical properties and are an excellent basis for creating a wide assortment of combined meat products.

The technology for production of sausages with dietary fiber, where soy dietary fiber acts as a functional ingredient, is patented. The product with the addition of soy dietary fiber has high organoleptic characteristics and dietary properties [40].

The authors described a method of obtaining a functional meat product containing the meal of medicinal plants: eleutherococcus root, valerian root, peppermint leaves, thyme herb and motherwort herb. The authors emphasize that the product is enriched with dietary fiber, essential oils and magnesium, which leads to improvement of intestinal peristalsis and hematopoiesis in the human body. In addition, the dietary supplement improves the structural properties, color, and organoleptic characteristics of the product [41].

In addition, there are canned meat with vegetable origin filler [42], containing high-grade trimmed beef, lean trimmed pork, pork fat, salt, sodium nitrite, vegetable filler - carrot, beet and sea cabbage. Such

product solves the problem of increasing the biological value of the product, balanced by the components of animal and plant origin, has high consumer properties among sausages with vegetable fillers.

The authors developed a sausage product for therapeutic and preventive and dietary nutrition, containing components of animal origin - poultry by-products, meat broth, melted chicken fat, components of plant origin - blanched mushrooms, barley or wheat flour, as well as table salt, pepper and water [43]

In the work [44] described that the protein isolate produced from peas can be used to make meat products without the use of modified (soy) or gluten-containing ingredients. Because of its high protein content (90%) and high emulsification ability with a low tendency to gelling, the isolate provides the necessary stability, good consistency and high yield of meat products at a low cost. To minimize the effect on taste and color of the product, up to 2% protein isolate is added to the recipe, either together with other dry ingredients or as a pre-cooked emulsion.

Danilov et al. (2019) investigated the nutritional value of sausage with the addition of extruded chickpea and wheat. The authors noted that the addition of up to 15% vegetable ingredients to the sausage recipe increases the content of dietary fiber, minerals and balances the amino acid composition [45].

Jasutiene et al. (2015) determined the effect of dried celery, parsnip and parsley on the change in physicochemical properties of sausages. It was found that the addition of vegetable additive affects the composition of sausages and the fermentation process. In the experimental sausages it was found that the fat content was less by 2 g/100 g and moisture content by 6 g/100 g compared to the control samples [46].

Andres et al. (2006) developed a low-fat chicken sausage (0.22% to 6.09% of fat content) by adding milk protein concentrate, xanthan and guar gums to the recipe. In addition, the authors note the improvement of organoleptic parameters and functional properties of the sausage [47].

Soy proteins are most commonly used in the production of meat products due to their functional properties and lower price. In work [48] it was noted that the addition of 2% soy protein isolate increases the moisture content, product yield.

The use of dietary fiber from processed vegetable raw materials can improve the nutritional value, rheological and sensory properties of meat products. Thus, Gringelmo-Miguel et al. (1999) used peach suspension dietary fiber in sausage formulations in amounts of 17% and 29%. The addition of peach dietary fiber lowers the pH, increases the protein and collagen content and improves sensory and rheological indicators [49].

Garcia et al. (2002) noted that the addition of cereal and fruit dietary fiber increases hardness and cohesiveness, while worsening the sensory and textural characteristics of fermented sausage [50].

In Yadav et al. (2016) the meat was replaced with corn bran, dried apple pomace, and dried tomato pomace in the amount of 3, 6, and 9%, respectively, during the production of sausages. The authors note that the protein and moisture content decreased significantly in all experimental sausages containing corn bran and dried apple pomace, while the ash content increased significantly in sausages with the addition of dried tomato pomace. The content of dietary fiber was significantly higher in all experimental sausages [51].

Hleap-Zapata et al. (2020) revealed that replacing up to 20% of wheat flour with pumpkin flour in the recipe of sausages made of beef and pork does not worsen the physico-chemical and textural properties

of the final product, and also increases the water-holding capacity and reduces weight loss, which has a positive effect from a technical and economic point of view [52].

Yerimyan (2016) developed canned meat from rabbit meat with the addition of 15% lentil flour. The study of the amino acid composition of the proteins of canned meat characterizes the completeness of its composition and a quite high level of total content of essential amino acids compared with the control samples [53].

In the patent [54] refers to the use of peanuts in the sausage recipe to improve the nutritional value of the sausage.

Conclusion

Production of meat products with the use of ingredients of both animal and plant origin not only expands the range of products, but also promotes the rational use of raw material resources, providing the population with quality food products. Plant raw ingredients give new dietary properties to the product, increase biological value, improve organoleptic indicators of finished products, reduce its cost. Thus, one of the priority directions in the creation of new technologies of functional products based on by-products are: replacement of a part of raw materials with secondary plant fillers; replacement of a part of meat raw materials by isolates or concentrates of proteins of a vegetative origin; combination of meat raw materials with vegetables, cereals and other plant products.

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