

ТЕХНІЧНІ НАУКИ

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THE ROLE OF PLANT COMPONENTS IN IMPARTING FUNCTIONAL PROPERTIES TO RESTRUCTURED MEAT PRODUCTS

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Subject. The physical, chemical and functional-technological traits of plant components used to impart functional properties to restructured meat products. **Purpose.** The work is reviewing scientific papers on functional meat products and, in particular, on the use of plant components to impart functional properties to restructured meat products – sausages, pâtés, etc. and the study of the properties of vegetable raw materials for adding these raw materials to the composition of functional pâté products. **Methods.** Within the framework of the research, we used the principles of a systematic approach to the research of factual materials, in particular scientific and professional sources, the results of previous research; abstract-logical approach to generalize the results of the study and formulate conclusions. **Results.** An analysis of a number of sources of scientific literature has shown that for the manufacture of functional restructured meat products, it is advisable to use a number of ingredients of plant origin, in particular, flour from the seeds of various crops (rice, corn, soybeans, flax, sunflower, etc.) and mixtures of various types of flour. The purpose of using flour in formulations of functional pâté products is, in particular, to enrich these products with proteins and polysaccharides. The content of the analyzed scientific sources also shows that the fatty acid composition of vegetable oils (sunflower, flaxseed, corn) and their blends contributes to the enrichment of meat restructured products with ω -6 and ω -3 fatty acids, that is, it implements the functionality of these products. The functional components of flour and oils normalize the functioning of the gastrointestinal tract and, in a technological sense, contribute to an increase in the moisture-binding capacity of the meat system and improve the sensorial and rheological properties of meat functional products. **Scopes of results.** The results of the study will contribute to further study of the technologies of functional pâtés intended for the nutrition of special categories of consumers as well as to the enhancing of technologies of functional pâtés in the practice of meat processing.

Key words: functional food products, functional meat products, restructured meat products, vegetable raw materials, flour, vegetable oil, fatty acid composition.

РОЛЬ РОСЛИННИХ КОМПОНЕНТІВ У НАДАННІ ФУНКЦІОНАЛЬНИХ ВЛАСТИВОСТЕЙ РЕСТРУКТУРОВАНІМ М'ЯСНИМ ПРОДУКТАМ

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Предмет. Фізико-хімічні та функціонально-технологічні характеристики рослинних компонентів, використовуваних для надання функціональних властивостей реструктурованим м'ясним продуктам. **Мета.** Огляд наукових праць щодо функціональних м'ясних продуктів і, зокрема використання рослинних компонентів для надання функціональних властивостей реструктурованим м'ясним продуктам – ковбасам, паштетам та ін., дослідження властивостей рослинної сировини для долучення зазначеної сировини до складу паштетних продуктів функціонального призначення. **Методи.** У рамках виконаних досліджень використовували принципи системного підходу до досліджень фактологічних матеріалів, зокрема наукових і фахових джерел, результатів попередніх досліджень тощо; абстрактно-логічний підхід щодо узагальнення результатів дослідження та формулювання висновків. **Результати.** Аналіз низки джерел наукової літератури показав, що для виготовлення функціональних реструктурованих м'ясних продуктів доцільно використовувати низку інгредієнтів рослинного походження, зокрема борошно з насіння різних сільськогосподарських культур (риса, кукурудзи, сої, льону, соняшнику та ін.) і суміші різних видів борошна. Метою використання борошна у рецептурах функціональних паштетних продуктів є, зокрема, збагачення зазначених продуктів продукту білками та полісахаридами. Зміст проаналізованих наукових джерел також показує, що жирнокислотний склад рослинних олій (соняшникової, лляної, кукурудзяної) та їхніх купажів сприяє збагаченню м'ясних реструктурованих продуктів ω -6 і ω -3 жирними кислотами, тобто реалізує функціональність зазначених продуктів. Функціональні компоненти борошна та олій нормалізують роботу шлунково-кишкового тракту, а у технологічному сенсі сприяють збільшенню вологозв'язувальної здатності м'ясної системи, поліпшують органолептичні та структурно-механічні властивості м'ясних функціональних продуктів. **Сфера застосування результатів.** Результати дослідження сприятимуть подальшому вивченню технологій функціональних паштетів, призначених для харчування спеціальних категорій споживачів, а також удосконаленню технологій функціональних паштетів у практиці м'ясопереробки.

Ключові слова: функціональні харчові продукти, функціональні м'ясні продукти, реструктуровані м'ясні продукти, рослинна сировина, борошно, олії, жирнокислотний склад.

Formulation of the problem.

Consumers' interest in healthy eating is growing around the world – scientists and professionals use their knowledge and experience to research functional properties and develop technologies for food production. These studies focus on the importance of creating new biologically valuable ingredients from natural raw materials, as well as a positive therapeutic effect in organizing the diet of patients with certain chronic diseases using functional foods and nutraceuticals, including functional and biological ingredients [1, 2].

The concept of functional food was developed in Japan in 1991, and since then it has been the subject of study due to the great market growth that this product category has experienced in recent decades [3-7]. A food is considered functional if it is shown that it exerts a beneficial effect on one or more selective functions of the organism, in addition to its intrinsic nutritional effects, so as to improve the state of health and well-being, reduce the risk of disease, or both [4, 8]. According to [9], there are quite a few definitions, but, in general, it is accepted that any food can be considered as such that, in addition to its nutritional value, provides some added and beneficial effect on health that goes beyond strict nutrition and that can be preventive or therapeutic. Experts argue that to be “functional”, a food must have conclusively demonstrated an effect to reduce the risk of suffering from pathology or act therapeutically on a certain disease, but not all comply. And they don't comply because to get what they promise, they would have to consume the amount equivalent to a truckload of that food every day. The purpose of functional products is diverse [10, 11]. They improve the general conditions of the body (for example, prebiotics and probiotics), reduce the risk of certain diseases (for example, cholesterol-lowering foods), and can be used to treat certain diseases [12-14]. In domestic scientific practice, the term “functional food products” refers to a wide range of food products: carriers of natural and organic substances, low-calorie and calorie-free products for weight control, foods enriched with vitamins and microelements, energy drinks, probiotic products, dairy products with specific

properties. To maintain human health, performance and longevity, it is very important to observe three basic principles of rational nutrition: energy balance; meeting the needs of the body in the required amount and ratio of nutrients; power mode [15].

However, the consumer faces various definitions [16] and progress in this field has been increasing, giving rise to confusion and conflicting attitudes. Therefore, we see the need for an exhaustive analysis in this field [4].

To achieve a full-fledged biological activity of nutrition, it is necessary to introduce correctly selected complexes of substances into the diet. Ingredients that give products functional properties should be natural and beneficial to health [15]. In [17], 6 main types of functional ingredients are defined: dietary fiber (soluble and insoluble); vitamins; minerals; polyunsaturated fats (vegetable oils, fish oil, ω -3 fatty acids); antioxidants (β -carotene, α -tocopherol, ascorbic acid); oligosaccharides, etc. According to [18], the main categories of functional food products are: natural products containing the required amount of a functional ingredient or groups of ingredients; natural products additionally enriched with any functional ingredient or group of ingredients; natural products in which a component is removed that prevents the manifestation of the physiological activity of the functional ingredients present; natural products in which the original potential functional ingredients are modified in such a way that they begin to show their biological or physiological activity; natural food products in which the bioavailability of functional ingredients is increased as a result of modifications; natural or artificial products that, as a result of the application of the above technological methods, acquire the ability to maintain and improve human health or reduce the risk of disease.

The production of functional food products based on meat raw materials is developing in the direction of expanding the species diversity of products, combining and optimizing the composition of products with the aim of achieving food and biological value, preserving the valuable components of raw materials, compensating for the lack of a number of macro- and micronutrients by including functional ingredients in the formulation. Regarding meat products, the efforts of specialists are mainly directed at their modification by changing the content of lipids and fatty acids and/or by adding a number of functional ingredients: fibers, plant proteins, monounsaturated or polyunsaturated fatty acids, vitamins, calcium, phytomaterials, etc. [19].

For all these reasons, for the meat sector, functional food constitutes an excellent opportunity to improve its “image” by offering a class of food more adjusted to the specific requirements of broad sectors of society, thus constituting an excellent opportunity to differentiation, diversification and positioning in an emerging market [20, 21].

It is possible to improve significant aspects of meat products that impact consumer health. Developing products with a health connotation opens up a new and important field both for the meat industry and for the market for this type of product. The new developed food has its principle in using meat as a vehicle and complementing it with those ingredients that can potentially affect health in a positive way. These ingredients can be added in a concentrated form or use vegetables that have active compounds. This not only presents a challenge for the meat industry but also for scholars, since in addition to developing new products, taking into account the active ingredient, it must validate that the products have real effects on the problem of chronic degenerative diseases [22, 23]. There are also numerous literature sources devoted to a number of valuable properties of functional meat products [24-28].

The subject is physical, chemical and functional-technological traits of plant components used to impart functional properties to restructured meat products.

The purpose of the work is reviewing scientific papers on functional meat products and, in particular, on the use of plant components to impart functional properties to restructured meat products – sausages, pâtés, etc. and the study of the properties of vegetable raw materials for adding these raw materials to the formulation of functional pâté products.

Research methods. Within the framework of the research, we used the principles of a systematic approach to the research of factual materials, in particular scientific and professional

sources, the results of previous research; abstract-logical approach to generalize the results of the study and formulate conclusions.

Research results. Targeted formulation change is one of the approaches to developing meat products that contain functional and fat-free additives while improving the fatty acid profile [29]. Experts point out three main goals associated with changing fat content and using structured emulsion strategies to change meat formulation: reducing total fat, cholesterol and changing fatty acid profile [30]. When formulating specialized meat-based food products, it is taken into account that the physiological effect is stronger when the protein component combines the proteins of animal and vegetable origin. Meat raw materials are rich in ω -3 and ω -6 fatty acids, but a proper balance is needed between them, which determines the functionality of products, in particular meat. To ensure the desired balance of the fatty acid composition of these meat products, vegetable raw materials – oils, flour, etc. are included in their formulations [31].

Functional foods contain functional ingredients that are added to benefit consumers. Studies have shown that these ingredients are probiotic bacteria, prebiotics, dietary fiber, synbiotics, antioxidants, polyunsaturated (ω -3) fatty acids, plant sterols, bioactive peptides, minerals and vitamins. As for meat products, it is important that the addition of functional ingredients to them would not change their properties and that new ingredients are present in the formulations in such quantities that positively effect the health of consumers [19, 29]. Modern production of functional food products based on meat raw materials is developing in the direction of expanding the diversity of products, combining and optimizing formulations in order to achieve nutritional and biological value, preserve the most important components of raw materials, and compensate for the lack of a number of macro- and micronutrients by using functional ingredients. It is widely practiced to modify meat products by changing the content of lipids and fatty acids and/or by adding fibers, vegetable proteins, monounsaturated or polyunsaturated fatty acids, vitamins, calcium, phytomaterials, and other ingredients [29]. The trend of using functional bioactive compounds in meat production is becoming more pronounced. Undoubtedly, these components can have a significant impact on human health, but the qualitative and quantitative composition of these substances should be properly selected. In particular, a significant issue is whether the product will be processed and, if so, what processing will be applied. Equally important in the development of functional meat products is the proper consideration of the deficiency of certain substances in the diet of specific consumer groups. The process of creating new meat products with functional properties is complex and depends not only on the effect of functional ingredients on the nutritional value of the final product, but also on how well it will be made [32]. It is practiced to impart functional properties to meat products in various ways, for example, by changing the fatty acid composition of meat raw materials by reducing the proportion of saturated fatty acids and increasing the proportion of monounsaturated and polyunsaturated fatty acids through the use of various vegetable oils [31].

It is necessary that the combined meat products have a high biological value due to the combination of meat raw materials with food and protein supplements of animal and vegetable origin, which are characterized by pronounced functional properties and the proper content of nutrients required by plant, animal and microbiological origin [33].

Perhaps the first meat products that parents and fosters offer to small consumers, meat and meat-and-vegetable pâtés are nutritious and delicate in texture. To create a pâté intended for children of preschool and school age, a general approach to the development of emulsion product formulations with the necessary modifications was used. To compile a generalized scheme (Figure 1) of the functional pâté recipe for these categories of consumers, the priority condition was precisely the proper functionality in terms of chemical composition, bioavailability, ratio of components, processing method, degree of grinding among themselves. with other physicochemical parameters of the product [31]. In particular, the composition used vegetable oils that have a pronounced antioxidant effect. They also effectively inhibit the growth of tumors, inactivate toxic substances and bacteria, and have anti-inflammatory and immunoprotective properties. To improve the fatty acid composition of meat products, it is

advisable to add vegetable oils in the form of emulsions [34, 35]. According to the above considerations, a functional pâté was created for the nutrition of children of preschool and school age, enriched with plant components, polyunsaturated fatty acids, with high nutritional and taste qualities, balanced in the content of proteins, fats, and minerals [36].

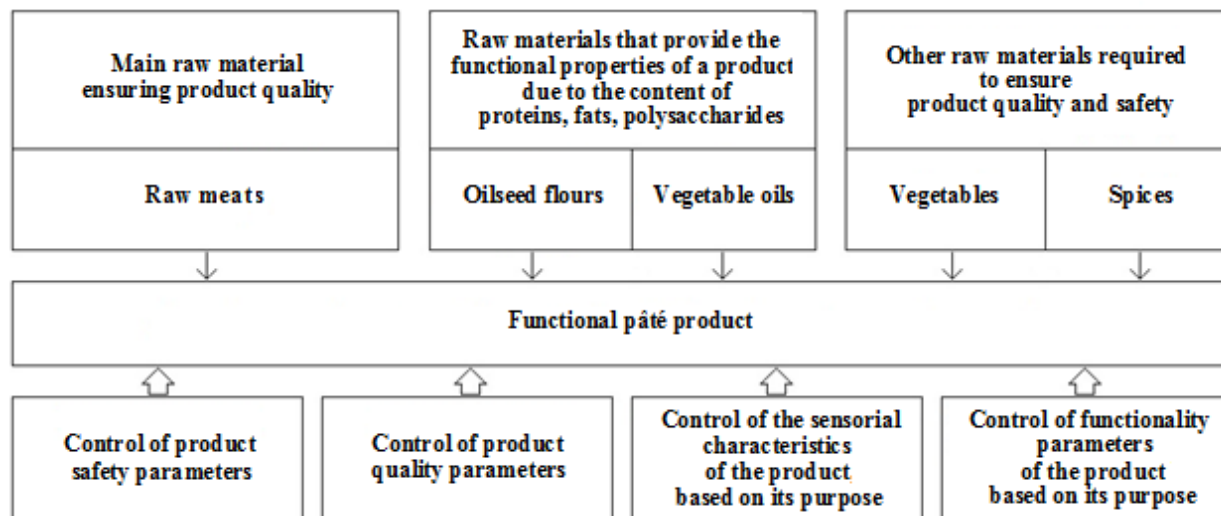


Fig. 1. Generalized scheme for the formation of a functional pâté recipe [36]

Flaxseed flour has long been used to form recipes for various functional products, since it is rich in complete proteins, dietary fiber, mineral elements, and vitamins [31]. The authors of [37] provide information on some of the important functional properties of flaxseed meal, not additionally processed, or processed as follows: partially defatted, not defatted fried, and also partially defatted fried. The results of these studies are presented in Table 1.

Table 1

Properties of flaxseed flour processed in various ways [37]

Physical and chemical parameters	Fried, not defatted	Not fried, not defatted	Fried, partially defatted	Not fried, partially defatted
Bulk density, g/ml	0.83	0.78	0.80	0.77
Moisture absorption capacity, g/g	1.83	1.48	2.34	2.20
Fat absorption capacity, g/g	1.31	1.20	1.27	1.04

The inclusion of flax flour in the minced lamb product made it possible to increase its water-retaining capacity, i.e., to improve the yield [38]. It also made it possible to increase the organoleptic acceptability of the finished product and its structural and mechanical characteristics: hardness, cohesion and elasticity. The addition of flaxseed flour in the amount of 1%, which turned out to be optimal under the research conditions, made it possible to significantly improve the storage capacity of the product. Consequently, the addition of flaxseed flour to the mince product had a positive effect both in the technological and economic sense.

The work [39] describes the addition of flaxseed flour as a functional ingredient to ground beef cutlets. Flour was added in the amount of 3, 6, 9, 12 and 15%. Control samples were made from 10 and 20% fat. With an increase in the content of flaxseed flour, the moisture and protein content decreased. The addition of flax flour did not affect the pH, reduced the loss of the product during heat treatment, and increased its energy value. The indicators of cutlets with flour content approached those of the control made from 10% fat. The content of alpha-linolenic acid in cutlets increased with the increase in the content of flaxseed flour. The ratio of ω -6 to ω -3 decreased from 5.76 for the control with 10% fat to 0.36 for cutlets with 15% flax flour. Already the addition of 3 or 6% flaxseed flour made it possible to improve the sensorial properties and

value of the product. The high fat-retaining capacity indicates the hydrophobic nature of the proteins in the flour, which physically bind the fat by capillary attraction. These proteins oppose fat with more odd amino acids and increase hydrophobicity, causing flour to absorb fat. This is a very important factor for the properties of meat products, in particular their shelf life [40, 41].

Defatted flour with increased fat-retaining capacity is more acceptable for inclusion in foods, in particular, this applies to corn flour [42]. This ingredient is one of those polysaccharide ingredients that have a positive effect on the water-retaining and fat-retaining capacity of minced meat products. The corn flour contains 8.3% protein, 59.8% starch and 4.85% lipids, as well as essential amino acids – 3000 mg / 100 g of the product. Practitioners believe that the optimal mass fraction of corn flour in formulations is 6% to achieve the optimal functional and technological properties of minced meat. The functional and technological properties of corn flour in the composition of meat products are positive. The above also applies to the functional and technological parameters of rice flour, namely, moisture-absorbing and fat-absorbing capacity [31].

Vienna-type sausage of beef, pork and back fat with partial substitution of meat for chickpea flour and lentil flour was made. The process consisted in emulsifying ingredients to obtain a Premium type product and a standard type product; an increase was found in the percentage of non-meat protein and starch in the product to which substitution was made. In conclusion, the sausage with the addition of lentil flour and chickpea flour is a functional product and has an assertive relationship between quality and cost [43].

Sunflower flour and protein concentrates from it are a valuable raw material for the manufacture of food products, because they have a high protein content, white color, mild taste and lack of reservations in terms of healthy nutrition. The specified raw material has an excellent fat-absorbing ability, and its potentially negative property is an excessive content of sugars [44, 45]. The acceptability of sunflower flour as an ingredient for the manufacture of meat products both in terms of functional and technological characteristics and in terms of sensorial properties is noted in [46] – especially no unwanted dark coloration. In the course of experimental production of minced meat products [47], sunflower flour was added in order to increase the fat content in them from 12 to 14%. This affected these products in a negative way, since their structure turned out to be too soft.

Vegetable oils are important components of functional foods. In particular, they contain sterols that have a distinct antioxidant effect, inhibit tumor growth, inactivate toxic substances and bacteria, and have anti-inflammatory and immune-protective properties. Therefore, the inclusion of vegetable oils in functional food formulations has a preventive effect on the occurrence of diseases such as cancer, type II diabetes, etc. [48]. To improve the fatty acid composition of meat products, it is recommended to add vegetable oils in the form of emulsions to their recipes [30, 49].

These features of vegetable raw materials, which give functional properties to pâté products, are fully used to formulate functional pâté products [50, 51], which is the topic of research, the course and results of which are reflected in this article.

Vegetable oils have also been used as partial substitutes for pork backfat in low-fat frankfurters and other types of cooked products, giving the products a more suitable fatty acid profile and cholesterol level than traditional ones [52, 53]. The studies characterized in [54] regarding the use of olive oil to replace 0% to 100% backfat for the production of frankfurters showed that high levels of olive oil obtained the lowest levels of global acceptance, although they were not affected the color attributes of the product. According to [52] traditional Spanish sausage was prepared, replacing 0% to 30% of the pork backfat with pre-emulsified olive oil. The levels of oleic and linoleic acid increased, and the cholesterol content was reduced, while the sensory characteristics (texture and color) were comparable with those of commercial products. The results indicated the possibility of replacing pork backfat with olive oil (above 25%) to increase the nutritional status of the products. Some authors [55] reported that the addition of olive oil to sausages was more effective than using vacuum storage methods to avoid lipid

oxidation during storage and also increased the fraction of monounsaturated fatty acids. Other studies [56] on salami found that the partial replacement of pork backfat by extra virgin olive oil did not significantly affect the chemical, physical, and sensory characteristics of the products, with the exception of water activity and firmness. The addition of extra virgin olive oil, rich in unsaturated fatty acids, did not reduce shelf life in terms of lipid oxidation, probably due to the antioxidant effect of both polyphenols and tocopherols. An alternative to using this vegetable oil, which is high in unsaturated fatty acids and liquid at room temperature, is to use interesterified vegetable oils. These can be used as fat replacement to modify the fatty acid composition of frankfurters and salami without negative changes in sensory characteristics. According to [57] frankfurters were produced with interesterified vegetable oils prepared from palm, cottonseed, and olive oils, and found that replacing bovine fat (10%) with such oils (60% to 100%) led to a significant increase in acid content. oleic and linoleic and polyunsaturated fatty acids ratio: no change in appearance, color, texture, flavor, or other sensory characteristics. The authors of [55] found that replacing pork backfat with linseed oil in the production of matured sausages decreased the n-6:n-3 ratio from 14.1 to 2.1 as a consequence of the increase in linolenic acid. These authors affirm that this had an important influence on the nutritional quality of these products, without significant changes in flavor or oxidation.

The intake of ω -3 has been associated with prevention-related anti-inflammatory effects of cardiovascular disease (CVD). Developing functional meat products could be of great interest to the consumers. The objective of the present study was to evaluate the effect of a functional meat with ω -3 and rosemary extract on markers of inflammation and oxidation in people with cardiovascular risk. The consumption of the foods with ω -3 and rosemary extract improves the inflammatory and oxidative state of people with at least 2 profile parameters altered lipid [58]. Strategies for enrichment in ω -3 fatty acids aiming for healthier meat products are described in [59].

To impart functional properties to meat products, soy [60] and walnut [61] processed products are introduced into the formulations. In [61], in particular, it was noted that the design and development of potentially functional meat products based on the addition of walnut has been addressed as part of a project whose goals range from the design and development of meat products in which nutrients associated with CVD risk are qualitatively and quantitatively modified to the study of bioavailability and the effect of consumption on intermediate markers of CVD risk in humans. By using technological strategies in the reformulation of meat matrixes, it has been possible to achieve products with a specific composition (less animal fat and sodium and fortified with various bioactive compounds) which present acceptable quality attributes in terms of physical, chemical and sensorial properties and stability. The range of plant raw materials used to impart functional properties to products is not limited to the above-mentioned types. In particular, [62] describes the production of such products from recycled poultry processing. Cuts generated from turkey and chicken breast were used to develop hamburger meat and breakfast sausage. Hamburgers were added 3% wheat fiber and 0.1% powdered rosemary extract as an antioxidant. The second product developed was a breakfast sausage with 3% fiber and 2.5% ferment of sugar as a salt substitute.

Consequently, the partial replacement of meat in meat products with protein raw materials of plant origin is justified in the economic and technological sense, and is also useful in terms of improving the nutritional value of these products [63-65]. Of the various forms of adding vegetable protein raw materials to the formulations of meat products, there are isolates that are inferior to flour in terms of their effect on the sensorial properties and suitability of products for storage [66, 67].

Conclusion. The research characterized in the sources of scientific literature analyzed in the article show that for the manufacture of functional restructured meat products, it is advisable to use a number of ingredients of plant origin, in particular, flour from the seeds of various crops (rice, corn, soybeans, flax, sunflower, etc.) and mixtures of various types of flour. The purpose of using flour in formulations of functional pâté products is, in particular, to enrich these

products with proteins and polysaccharides. The content of the analyzed scientific sources also shows that the fatty acid composition of vegetable oils (sunflower, linseed, corn) and their blends contributes to the enrichment of meat restructured products with ω -6 and ω -3 fatty acids, that is, it implements the functionality of these products. The functional components of flour and oils normalize the functioning of the gastrointestinal tract, and in a technological sense, contribute to an increase in the moisture-binding capacity of the meat system, improve the sensorial and rheological properties of meat functional products.

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