

**INFLUENCE OF NON-TRADITIONAL RAW MATERIALS OF
VEGETABLE ORIGIN ON THE QUALITY OF SAUSAGE FOR DIETARY
NUTRITION**

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The purpose. Study of the effect of hemp, pumpkin, and black cumin flour on the quality characteristics of sausages for dietary nutrition. Methods. The pH value was determined potentiometrically, the mass fraction of protein was determined by the content of total nitrogen according to Kjeldahl with the subsequent distillation of ammonia; mass fraction of moisture - by drying the weight to a constant mass at a temperature of 105 °C; mass fraction of fat - by the Soxhlet method; mass fraction of ash - by the method of dry mineralization in a muffle furnace; organoleptic value - according to a five-point system; emulsifying ability and emulsion stability - according to the Khoinovsky method. The object of research was: model samples of sausages (control and two experimental ones with the addition of hemp flour, pumpkin flour, and black cumin). The results. Physico-chemical, functional-technological, and rheological indicators of sausage samples were studied. Research results show that the addition of pumpkin and hemp flour and black cumin to the experimental samples increases the protein content in the finished products by (1.3-1.7) %, and reduces the fat content by (5.8-6.9) %, compared to control samples. Determination of moisture-binding and emulsifying capacity showed an increase in samples with hemp and pumpkin flour by (2.87 - 4.01) % and (1.69 - 1.81) %, respectively, compared to the control sample. When studying the structural and mechanical parameters of sausages, it was established that the addition of hemp and pumpkin flour

during production helps to reduce their stiffness and increase juiciness. **Conclusions.** The obtained results of research indicate the expediency of using non-traditional raw materials of vegetable origin in the production of sausages for dietary nutrition.

Key words: dietary products, meat products, hemp flour, pumpkin flour, black cumin, sausages for dietary food.

Dietary nutrition is based on the theory of balanced nutrition.

Dietary products are specialized products that replace traditional products in the nutrition of patients and differ from them in chemical composition and/or physical properties. According to the classification [1], they are divided into 7 groups (Fig. 1).

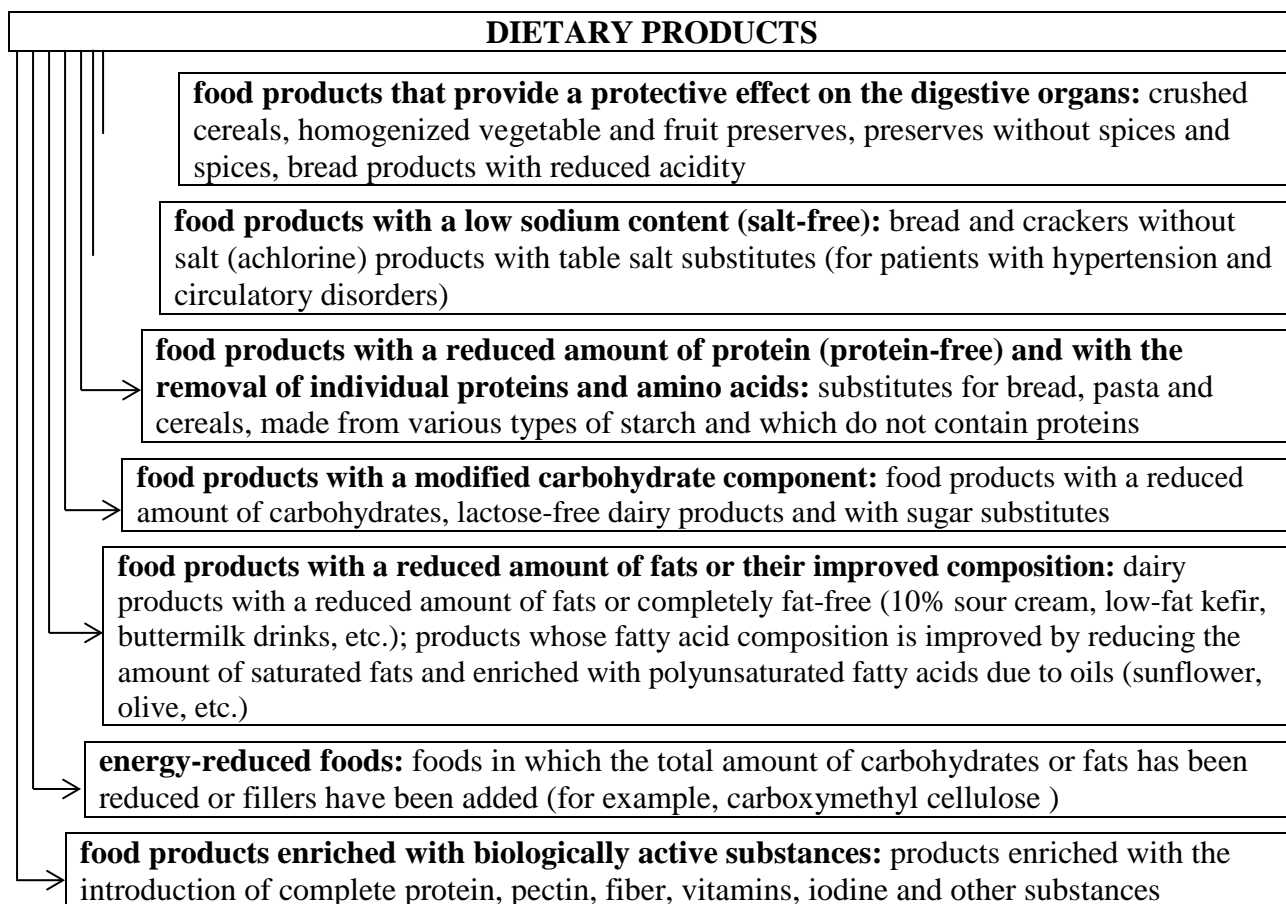


Fig. 1 Classification of dietary food products

Meat products occupy a special place among dietary products.

In general, the following groups of meat products that are used in dietary nutrition can be distinguished:

- low-calorie products enriched with dietary fibers;

- enriched with vitamins;
- produced using mineral substances;
- produced using polyunsaturated fatty acids;
- enriched with prebiotics and probiotic cultures of microorganisms.

Meat and meat products are one of the most difficult bases for creating dietary and medical and preventive products, although, from the point of view of healthy nutrition, meat is one of the most important products - along with vegetables, fruits and dairy products. All nutraceuticals, essential amino acids, iron, vitamins of group B that are necessary for life enter the human body with meat. The best source of functional ingredients for the production of meat products is raw materials of plant origin [2].

Meat and meat products have high nutritional and biological value. The nutritional value of meat depends on the ratio of muscle, connective and fatty tissues, the content of extractive substances. The more muscle tissue and the less connective tissue, the higher the nutritional value of the meat, and the higher the level of absorption of nutrients. The nutritional value is determined by the ratio of tryptophan (characterizes the content of muscle tissue) and oxyproline (characterizes the content of connective tissue): 5.8 - high nutritional value of meat; 4.8 – average nutritional value; 2.5 is a low value.

The high nutritional value of meat determines its high technological properties and makes it possible to produce a wide range of products with acceptable organoleptic quality indicators by various methods of culinary processing.

In the production of meat products, the fatty acid composition can be modified by introducing vegetable fat (a mixture of linseed and sunflower oil or sunflower and corn oils) [3-5].

High-quality meat products can be obtained with a decrease in sodium chloride content. The World Health Organization (WHO) recommends consuming 5 g of salt per day. Studies have shown that it is possible to reduce the salt content in meat products to 1.7% without changing its quality characteristics. This effect is produced

by the use of other chlorides (KCl, MgCl₂, CaCl₂), as well as non-chloride salts, for example, lactates and phosphates [6].

Sodium nitrite plays a major role in forming the color and taste of meat products, and also suppresses the reproduction of pathogenic bacteria *Clostridium botulinum*. Currently, the task is to reduce the amount of sodium nitrite in meat products and partially replace it with other components. Due to its high reactivity and ability to form N-nitrosoamine, including the carcinogenic N-nitroso-dimethylamine (NDMA), it is desirable to limit the use of sodium nitrite. For effective inhibition of nitrosamine formation in the presence of oxygen, it is recommended to use ascorbic acid. The most important lipophilic substance that inhibits nitrosation is alpha-tocopherol [7].

Currently, there is a tendency to increase various types of antioxidants during the production of dietary products.

Antioxidants of vegetable origin are obtained from such plants as rosemary, green tea, olives, grapes, etc. They are used to inhibit the process of lipid oxidation [8].

Dietary fiber is important in functional (dietary) nutrition. Regular consumption of fiber has a positive effect on human health. Dietary fibers also have technological significance. They increase the water-binding capacity of meat, bind cations, emulsify fat and increase the viscosity of meat systems. The use of dietary fibers in the meat industry leads to better preservation of the shape of heat-treated meat products [7-9].

Specialists of the National University of Food Technologies have developed liver pate, which contains pumpkin and Jerusalem artichoke pulp powder [10]. Making pate according to the proposed recipes allows you to get a product with optimal organoleptic indicators and high biological value. In addition, the product can be used as a functional product for the elderly and people with diseases of the gastrointestinal tract and cardiovascular system.

The author [11] suggests adding rosemary extract and sodium ascorbate to the pork liver pate, which slow down the process of lipid oxidation.

The Odesa National Academy of Food Products conducted a study on the possibility of combining rabbit meat with an unconventional ingredient - bulgur grain in meat products [12]. It has been established that replacing up to 3% of rabbit meat with bulgur groats makes it possible to obtain chopped meat-vegetable semi-finished products for herodietary nutrition of acceptable quality and distinct dietary properties.

The Kherson National Technical University investigated the possibility of adding plant fiber (wheat germ, pumpkin seeds, oats, and flax seeds) to the composition of cooked turkey sausages [13]. It has been proven that the addition of vegetable fiber has a positive effect on the organoleptic and physicochemical properties of cooked sausage products, while the beneficial properties of the proposed vegetable fibers allow the production of fiber-enriched products.

When analyzing the market of functional food products, it was found that the value of the world market of fortified food products is estimated at

180.58 billion USD in 2021. In 2022, according to forecasts, it can grow to 191.68 billion dollars at an average annual growth rate (CAGR) of 6.1%. The functional food market is expected to grow to \$243.83 billion in 2026 at a CAGR of 6.2% [14]. In the European market of functional food products during the forecast period (2021-2027), the average annual growth rate of the market will be 8.3% [15]. The COVID-19 pandemic has increased consumer interest in healthy eating, with a significant increase in the number of people expecting food to have a functional benefit such as an immune-enhancing effect.

The demand for functional foods has increased over the last decade as new types of products have appeared in the food industry. Consumers positively perceive such functional products as special bakery products, breakfast cereals, snack products (bars, dairy products, children's and dietary food, etc.). Protein is becoming a priority for consumers around the world because it is considered to be "anti-fat" and "anti-sugar" as well as a powerful source of energy.

Sausage products are used in dietary nutrition - sausages, sausages of the highest grade. These products differ in the small content of spices, finely chopped

minced meat, the addition of milk and eggs [16]. Boiled sausage products are one of the most common groups of meat products, therefore researching the quality characteristics of meat systems using non-traditional components of animal and vegetable origin is an urgent task today.

The purpose of research. Study of the influence of non-traditional raw materials of vegetable origin (hemp, pumpkin, black cumin flour) on the physico-chemical, functional-technological and rheological parameters of sausages for dietary nutrition.

Research materials and methods. The study of physical and chemical parameters was carried out according to known methods. The reliability of the results was ensured by the analysis of studies conducted in triplicate.

Research results. Samples of sausages were made in industrial conditions for the purpose of researching their quality indicators. Three samples were produced - the control one according to TU U 10.1-00419880–164:2021 "High grade sausages. Technical conditions" and two experimental ones, the recipes of which are given in the table. 1.

Table 1 – Sausage recipes

The name of the raw material, spices and materials	Norm, kg/100 kg		
	Sample		
	Control	Recipe 1	Recipe 2
Turkey or chicken fillet	50	50	50
Boneless lean pork	20	20	15
Boneless semi-fat pork	28	13	13
Milk is dry	2	2	2
Hydrated pumpkin flour	-	15	-
Hydrated hemp flour	-	-	20
Spices and materials, g (per 100 kg of unsalted raw materials)			
Kitchen salt	2000	1900	1900
White sugar	200	190	200
Ground nutmeg	100	-	-
Cardamom extract	50	-	-
Black cumin	-	150	100
Sodium isoascorbate	50	50	50
Sodium nitrite	5	3	3

The experimental sample according to recipe № 1 was made with the addition of hydrated pumpkin flour in the amount of 15 kg per 100 kg of unsalted raw materials; sample according to recipe № 2 was made with the addition of hydrated hemp flour in the amount of 20 kg per 100 kg of unsalted raw material.

The results of the study of the physicochemical composition of the control and test samples of sausages are shown in Table 2.

Table 2 – Physico-chemical indicators and energy value of sausages

Sample	pH	Content, %					Energy value, kcal
		Moisture	White	Fat	Ash	Coal - water	
Control	6.19 ± 0.01	60.1±2.06	12.1 ± 0.12	25.1 ± 0.22	1.9±0.05	0.8±0.29	277.5±2.6
Recipe 1	6.51 ± 0.04	62.1±2.18	13.4±0.15	19.3±0.19	2.8±0.09	2.4±0.28	236.9±1.3
Recipe 2	6.32 ± 0.07	61.3±2.12	13.8±0.18	18.2±0.17	2.1±0.06	4.6±0.30	237.4±1.8

As shown in the table, in the experimental samples there is a pH shift towards the alkaline side relative to the control sample. This is probably due to the fact that pumpkin and hemp flour does not contain a large amount of monosaccharides, which causes pH changes in the alkaline direction. The addition of pumpkin and hemp flour, as well as black cumin flour to experimental samples increases the protein content in finished products by (1.3-1.7) %, while reducing the fat content by (5.8-6.9) % compared to control samples. The chemical composition of sausages is characterized by high nutritional value, a balanced protein-fat composition and meets the requirements of the group of products for dietary nutrition.

According to the research results, the addition of pumpkin and hemp flour to minced sausages contributed to the improvement of their functional and technological indicators and increased yield (table 3).

Table 3 – Functional and technological indicators of sausage samples

In percentages

Sample	Moisture binding capacity	Water holding capacity	Emulsifying ability	Emulsion stability	Product yield, %
Control	78.18±3.09	56.13±2.25	53.22±1.64	71.98±2.93	108.5±2
Recipe 1	81.05±4.15	66.01±3.09	55.03±1.93	82.01±4.34	113.2±2
Recipe 2	82.19±4.23	65.28±2.88	54.91±1.75	82.18±4.50	115.4±2

Moisture-binding capacity (WBH) is an important functional characteristic that determines the organoleptic and rheological properties of the product. The VZZ indicator of the experimental samples was (81.05-82.19) %, which is (2.87-4.01) % higher compared to the control. The water-holding capacity (WHC) of samples with hemp and pumpkin flour was higher by (9.15-9.88)% than in the control sample. The addition of hemp and pumpkin flour made it possible to improve the properties of minced meat before emulsification. The emulsifying capacity (EC) of the sample with hemp flour increased by 1.69%, with pumpkin flour - by 1.81% compared to the control sample. The emulsion stability (SE) of the samples also increased. Improvement of the functional and technological indicators of the samples of the studied sausages ensured an increase in yield: for samples with hemp flour - by 6.9%, with pumpkin flour - by 4.7%. This makes it possible to save from 15% to 20% of meat raw materials.

The increase in the moisture-binding and water-retaining capacity of the studied sausage samples is probably explained by the influence of plant proteins of hemp and pumpkin flour, which interact with muscle proteins, contribute to moisture retention, improving the functional and technological properties of meat systems.

The structural and mechanical properties of sausages were determined by indicators of shear stress, cutting work and shear force (Table 4).

Table 4 – Structural and mechanical indicators of sausages

Sample	Structural and mechanical indicators		
	Shear force, N	Shear stress, 10^3 , n/m ²	Cutting work, J/m ²
Control	9.61±0.25	36.1±1.05	543.5±5.89
Recipe 1	8.24±0.19	32.4±0.93	501.3±5.68
Recipe 2	8.01±0.15	31.1±0.89	490.1±4.95

The results of studies of the structural and mechanical indicators of the studied sausages indicate a decrease in stiffness and an increase in juiciness in sausages using pumpkin and hemp flour, which is also confirmed by the organoleptic evaluation of the product (table 5).

The decrease in strength properties is obviously associated with an increase in the moisture-holding capacity of the samples, as well as a decrease in the proportion of meat proteins, which are characterized by greater mechanical strength than vegetable proteins.

Table 5 – Organoleptic indicators of sausages

Sample	Appearance	Consistence	Sectional view	Taste	Scent	In points
						Overall assessment mark
Control	4.9	4.4	4.7	4.8	4.5	4.6
Recipe 1	4.8	4.5	4.8	4.8	4.6	4.7
Recipe 2	4.9	4.5	4.8	4.7	4.7	4.7

According to all indicators, the studied samples of sausages met the regulatory requirements that are put forward for similar products.

Conclusion. According to the results of the research, it can be stated that the addition of hemp flour, pumpkin flour and black cumin has a positive effect on the physico-chemical, functional-technological, rheological and organoleptic properties of sausages for dietary nutrition, therefore, taking into account the useful properties of the indicated vegetable raw materials, it is possible to recommend the production such sausages on an industrial scale.

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