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RESEARCH OF QUALITY PARAMETERS OF FIRST-GRADE «GERODIIETYCHNA» COOKED SAUSAGE

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Subject. *Technology of first-grade cooked sausage «Gerodiietychna».* ***Purpose.*** *To determine physical, chemical, functional and technological properties of first-grade cooked sausage «Gerodiietychna».* ***Methods.*** *The objects of the study were samples of first-grade cooked sausage «Gerodiietychna», made with the addition of oat and amaranth flour, corn oil and black cumin. The mass fraction of water, protein, fat, ash and pH were determined using known laboratory methods; water activity (a_w) – using the AquaLab 3 TE device; water-binding capacity – by pressing the test sample; the amino acid composition of proteins was studied after hydrolysis of the product samples; the mass fraction of carbohydrates – according to the formula: 100 – (protein + water + fat + ash); a comprehensive sensorial evaluation – on a five-point scale.* ***Results.*** *The quality parameters of first-grade cooked «Gerodiietychna» sausage, formulated with oatmeal, amaranth flour, and black caraway, were compared to cooked «Diabetychna» sausage. It was found that the use of these plant-based ingredients increased the protein content of the finished product by 1.5% and decreased the fat content by 3.7% compared to the control. The caloric content of the test samples was 6.3% lower than that of the control samples, which is important for gerodietetic nutrition. The watere-binding capacity of the test samples was almost 2% higher than that of the control samples. The emulsifying capacity of the test samples increased by 1.77% compared to the control samples. Improved functional and technological parameters of the test samples resulted in a 2.5% increase in yield and a savings of up to 12% in raw meat. Consequently, the use of oat flour, amaranth flour and black cumin in the formulations of cooked sausages with a gerodietetic focus contributes to the improvement of physical, chemical, functional and technological parameters.* ***Scopes of results.*** *A technology has been developed for manufacturing first-grade «Gerodiietychna» cooked sausage using oat flour, amaranth flour, and black cumin. The technology has been tested under industrial conditions.*

Key words: *pH value, quality parameters, gerodietetic products, oat flour, amaranth flour, black cumin, cooked sausages*

ДОСЛІДЖЕННЯ ПОКАЗНИКІВ ЯКОСТІ ВАРЕНОЇ КОВБАСИ «ГЕРОДІЄТИЧНА» ПЕРШОГО СОРТУ

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Предмет. *Технологія вареної ковбаси «Геродієтична» першого сорту.* ***Мета.*** *Визначення фізико-хімічних та функціонально-технологічних показників вареної ковбаси «Геродієтична» першого сорту.* ***Матеріали та методи.*** *Об'єктом досліджень слугували зразки вареної ковбаси «Геродієтична» першого сорту, виготовлені з додаванням вівсяного та амарантового борошна, олії кукурудзяної та кмину чорного. Масову частку вологи, білка, жиру, золи та значення pH визначали за допомогою відомих лабораторних методів; активність води (a_w) – за допомогою приладу AquaLab 3 TE; вологозв'язуючу здатність – методом пресування досліджуваної проби; амінокислотний склад білків досліджували після гідролізу зразків продукту; масову частку вуглеводів – за формулою: 100-(білок+волога+жир+зола); комплексна органолептична оцінка – за п'ятибальною шкалою.* ***Результати.*** *Досліджено показники якості вареної ковбаси «Геродієтична» першого сорту з використанням у рецептурі борошна вівсяного, амарантового та кмину чорного порівняно з вареною ковбасою «Діабетична». Встановлено, що використання зазначених компонентів рослинного походження збільшує вміст білка в готовому виробі на 1,5%, а вміст жиру знижує на 3,7% порівняно з контролем. Калорійність дослідних зразків на 6,3% нижче по відношенню до контрольних зразків, що є важливим у геродієтичному харчуванні. Вологозв'язуюча здатність дослідних зразків була майже на 2% вищою ніж у контрольних зразках. Емульгуюча здатність дослідних зразків підвищилась на 1,77% порівняно з контрольними зразками. Покращення функціонально-технологічних показників дослідних зразків забезпечує підвищення виходу на 2,5% і дає можливість заощадити до 12% м'ясної сировини. Отже, використання борошна вівсяного, амарантового та кмину чорного у рецептурах варених ковбас геродієтичної спрямованості сприяє покращенню фізико-хімічних та функціонально-технологічних показників.* ***Сфера застосування результатів.*** *Розроблено технологію виробництва ковбаси вареної «Геродієтична» першого сорту з використанням борошна вівсяного, амарантового та кмину чорного. Розроблена технологія випробувана у промислових умовах.*

Ключові слова: *величина pH, показники якості, геродієтичні продукти, борошно вівсяне, борошно амарантове, кмин чорний, варені ковбаси*

Statement of the problem. The problem of providing consumers with high-quality safe and nutritionally complete foods has become especially relevant amid the growth of the share of elderly people in the population structure. According to the global initiatives of the WHO and FAO, the formation of a healthy food environment is a critical factor in the prevention of chronic diseases and the extension of active longevity [1].

In accordance with the concept of balanced nutrition, the structure of the diet of the elderly and the elderly should be adapted to age-related changes in metabolism and the functional state of the enzymatic systems of the digestive organs. Reduction of energy needs, reduction of muscle mass and deterioration of nutrient absorption requires correction of nutrition with an emphasis on high biological value of proteins, a sufficient amount of dietary fibers, antioxidants, minerals and vitamins [2].

It has been scientifically proven that proper nutrition is a key factor determining the quality of life elderly people. Nutrition plays a vital role in ensuring a high level of health, increasing life expectancy, maintaining human performance, and reducing the risk of sarcopenia, osteoporosis, and cardiovascular and metabolic disorders [3]. At any age, it should meet the body's needs for essential nutrients and energy, and in old age, it should also prevent the development of premature aging.

The following key approaches to providing the Ukrainian consumers with gerodietetic products are identified:

- developing formulations and production technologies for various products by adjusting their nutrient composition;
- creating special biologically active food supplements and fortifying food products with them;
- developing special therapeutic and prophylactic products for younger people to prevent the development of pathologies [4].

Gerodietetics is an independent scientific discipline that considers the nutritional needs of the elderly, as well as the quantity and quality of food, to prevent virus-related diseases and premature aging. The development of new gerodietetic products, their composition being optimized to meet the metabolic and functional needs of the aging body for various nutrients, not only corrects

nutritional deficiencies in the elderly but also reduces the risk of age-related pathologies, improves the quality of life of the elderly, and slows the processes of cellular and systemic aging [5].

Meat products are an integral part of the daily diet of virtually all ages, including the elderly. Their multi-component nature, thanks to the use of raw materials with different chemical compositions, makes it possible to create products that meet the principles of gerodietetics.

Animal proteins found in meat and fish, animal fats, and seafood are complete in terms of amino acid composition. It is important to keep in mind that when protein intake in the elderly is reduced compared to the norm, the body's resistance to infections is reduced and nitrogen balance is disrupted. At the same time, excess protein increases the load on the heart, liver, and kidneys [6, 7]. Lean beef, chicken, and rabbit should be consumed as meat products. Offal and eggs should be consumed in moderation because they are rich in nucleic acids and also contain cholesterol.

The recommended fat intake is 0.8–1.0 g/kg of body weight. Lipid sources in the diet should include foods containing triglycerides, lipotropic substances (e.g., lecithin), and others. Vegetable fats should account for 1/3 of all fats. However, it is not advisable to significantly increase the proportion of vegetable fat in the diet, as this can complicate digestion and fat utilization, and may also have a negative impact on the thyroid gland, whose function is weakened in old age. Butter should also be included in the diet. Although it contains cholesterol, it is a source of lecithin-protein complexes, which have lipotropic and anti-sclerotic effects [8].

Carbohydrates are a source of easily mobilized energy and, through intermediate metabolism, participate in the synthesis of lipids, amino acids, and nucleic acids. Excessive carbohydrate consumption is usually accompanied by increased carbohydrate storage in fat depots. Carbohydrate deficiency, as a rule, contributes to increased endogenous fat production and, as a result, acidosis and disruption of protein metabolism [9].

It should be acknowledged that the development of gerodietetic nutrition products is limited, and the domestic food industry practically does not produce specialized food products intended for the elderly. Food production technologies typically do not take into account scientific advances and the specific nutritional needs of older adults, despite the fact that the experience of specialists in medicine, dietetics, and gerontology demonstrates the need to develop and implement technology for the production of meat-based gerodietetic products as a factor in the prevention of pathologies occurring instead of physiologically normal aging of elderly.

Geroprotectors play a key role in the development of gerodietetic products. These are nutrients that slow the aging process, improve health, and enable people to remain active even in old age, prolonging longevity. This requires enriching foods with nutrients such as vitamins, minerals, polyunsaturated fatty acids, dietary fiber, and naturally occurring biologically active components that boost immunity.

Vitamins and minerals are components of enzymes and are essential for virtually all metabolic processes in the body. Their need increases with age. This is due to the development of endogenous vitamin deficiency in old age and vitamin deficiencies in the diet. Of particular interest is the analysis of vitamin requirements for antioxidants and geroprotective vitamins. Against the background of a reduction in the caloric content of food, they should be satisfied through vegetables and fruits, seafood (iodine, selenium, vitamin D), fermented milk products with a high content of biologically active substances, whole grains, and nuts [10].

Calcium-rich foods are especially important in the diet, as they contribute to bone formation (99% of the body's calcium is found in bone and teeth), blood clotting, and the reduction of vascular permeability. Calcium absorption depends on its balance with other nutrients in foods and dishes, particularly phosphorus, whose excess in food contributes to the formation of insoluble calcium salts, which reduce its absorption [11, 12].

The issue of balanced nutrition for the elderly population is of significant socioeconomic significance. The range of healthy foods for a large age group is quite limited, and culinary products that promote the prevention and treatment of geriatric diseases are virtually nonexistent. The development of cutting-edge technologies for health-promoting products for the elderly is currently crucial.

One of the current trends in the development of meat-based gerodietetic products is the use of plant-based raw materials, especially those from local regions. Such ingredients: serve as a source of important nutrients: proteins, fiber, microelements, antioxidants, and polyunsaturated fatty acids; and possess biologically active components that more effectively influence the metabolism of the elderly. The use of plant-based raw materials native to the region of human habitation increases bioavailability and synergy with nutrients in the traditional diet. This allows:

- to preserve the product's taste;
- to reduce dependence on imports and optimize processing technology;
- to facilitate the body's adaptation to the consumption of these products [13].

Studies of the feasibility of using sprouted cereal and legume grains in the production of meat-plant semi-finished products for gerodietetic nutrition have shown that the studied raw materials are complete in terms of nutritional and biological value and can be recommended for the development of a gerodietetic product that provides the body with substances whose deficiency plays a decisive role in the occurrence and development of so-called "age-related" diseases [14].

To overcome nutrient deficiencies, it is advisable to use plant-based raw materials, such as hemp, pumpkin, pea, and black cumin flours, as promising components for creating fortified food products. Research on restructured meat products confirms the positive impact of plant-based components on the physicochemical and functional and technological properties of these products [16, 17].

Among the wide range of plant-based ingredients, oats and amaranth – ancient cereals with a unique nutrient composition (protein, fiber, polyunsaturated fats, minerals, and antioxidants) – are particularly noteworthy. Their use in the production of meat products, particularly cooked sausages, opens up new possibilities for creating functional, gerodietetic products that combine traditional flavor characteristics with a preventative effect. This approach aligns with modern global trends in healthy eating, reducing the energy density of foods, and maintaining nutrient balance [18].

Oats (*Avena sativa* L.) are a cereal grain rich in protein, soluble fiber (β-glucans), minerals, B vitamins, and bioactive compounds [19].

Oat flour contains up to 17% protein (80–90% globulins and albumins). The β-glucans found in oats lower cholesterol, stabilize glucose levels, improve intestinal function, and have prebiotic properties, making them important in the nutrition of the elderly. Oats also contain significant amounts of amino acids: glutamine, leucine, isoleucine, threonine, valine, methionine, arginine, and lysine, which is deficient in most cereals. Oat flour contains more lysine than wheat or corn flour, increasing the overall biological value of the protein. Oats also contain large amounts of vitamins and minerals. Particularly important: high content of iron (4–5 mg/100 g) and magnesium (≈150 mg/100 g), which is beneficial for hematopoiesis and the cardiovascular system [20].

Amaranth surpasses wheat flour in its energy value and easily digestible protein content (79% to 97%). Amaranth's protein quality is considered very high due to its significant sulfur amino acid and lysine content, which is three times higher than that of corn and sorghum, and comparable in quantity to soy and cow's milk. Lysine is known to be a valuable essential amino acid, as it cannot be synthesized in tissues; humans obtain it only from plants [21].

Amaranth's characteristic ratio of saturated to unsaturated fatty acids is quite close to the physiological needs for nutrients and energy for an adult.

Amaranth is also characterized by a high macronutrient composition. It contains high levels of magnesium and calcium [22]. Amaranth differs from traditional grains in that it contains only a small amount of prolamin, making it safe for people with celiac disease or gluten sensitivity. Albumins, globulins, and glutelins in amaranth protein do not cause allergic reactions in most people with gluten intolerance. Due to its low prolamin content and the high quality of other proteins, amaranth is an excellent alternative for gluten-free products [23]. Therefore, the use of amaranth flour in the production of gerodietetic meat products is relevant.

Therefore, our study aims to evaluate the effectiveness of oat, amaranth, and black caraway flour in cooked sausage recipes and determine the impact of these ingredients on the quality of the

finished product. The study aims at developing a technology for the production of cooked sausages that meets due food safety requirements and healthy nutrition for the elderly.

Purpose of the study was to determine the physicochemical and functional-technological properties of first-grade cooked sausage «Gerodiietychna».

Materials and methods. The objects of the study were samples of cooked sausages «Diabetychna» (Control), manufactured in accordance with DSTU 4436:2005 «Cooked sausages, frankfurters, sardellas, meat loaves. General specifications» [24] and «Gerodiietychna» first grade (Experiment) made from beef, pork, turkey fillet and with the addition of oatmeal (6%), amaranth flour (4%), and corn oil (2 kg per 100 kg of unsalted raw materials). The hydration level of oatmeal and amaranth flour was 1:3. The mass fraction of water was determined by drying the sample to a constant weight at a temperature of 105ºC; The mass fraction of protein was determined based on the total nitrogen content using the Kjeldahl method with subsequent distillation of ammonia; the mass fraction of fat was determined using the Soxhlet method; the mass fraction of ash was determined using the dry mineralization method in a muffle furnace; pH was determined potentiometrically; water activity (aw) was measured using the AquaLab device; moisture-binding capacity was measured by pressing the test sample [25]; the amino acid composition of proteins was studied after hydrolysis of product samples; the mass fraction of carbohydrates was determined using the formula: 100-(protein+water+fat+ash); sensorial assessment was performed using a five-point system in accordance with DSTU 4823.2:2007 «Meat products. Organoleptic evaluation of quality characteristics. Part 2. General requirements».

Results. Physical and chemical parameters are critical for determining the safety and quality of meat products, as they influence sensorial characteristics (taste, aroma, texture) and the preservation of the product's beneficial properties throughout its shelf life [26, 27]. For cooked sausages, important parameters include moisture, fat, protein, carbohydrate content, water-binding capacity, and active acidity [28, 29].

The chemical composition of food products is one of the most important nutritional indicators. Table 1 shows the results of determining the physical and chemical parameters, energy value of first-grade «Gerodiietychna» cooked sausage.

Table 1

Physical and chemical parameters, energy value of first-grade «Gerodiietychna» cooked sausage

Parameter	Control	Experiment
Water content,%	62.2	60.2
Protein content,%	16.9	18.4
Fat content,%	18.5	14.8
Ash,%	2.1	2.9
Carbohydrates,%	0.3	3.7
pH, units	6.22	6.41
Energy value, kcal	235.3	220.6

According to the data in the table, experimental samples with oat and amaranth flour increase the protein content in the finished product by 1.5%, and reduce the fat content by 3.7% compared to the control samples. The active pH of the experimental sample is higher by 3.1% compared to the control sample. The energy value of the experimental samples is 6.3% lower than in the control samples, which is important in the gerodietetic nutrition.

The sensorial evaluation of the samples was carried out on a 5-point scale (table 2).

Table 2

Results of sensorial evaluation of first-grade «Gerodiietychna» sausage (in points)

Parameter	Control	Experiment
Appearance	4.90	4.90
Consistency	5.00	4.90
Cut View	4.80	4.80
Color	4.90	4.80
Smell	4.70	4.80
Taste	4.80	4.90
Juiciness	4.50	4.70
Overall Rating	4.80	4.82

Analyzing the results of the sensorial evaluation of the cooked sausage samples, it can be noted that the experimental sample exhibited aroma, flavor, and color nuances characteristic of the added plant materials (oat flour and amaranth). All parameters of the cooked sausage samples met the regulatory requirements for similar products.

The following functional and technological parameters of the gerodietetic sausage were studied: water-binding capacity, water-holding capacity, emulsifying capacity, emulsion stability, and yield (%).

According to the results, the addition of oat flour, amaranth flour, and corn oil to the sausage mince improved its functional and technological parameters (table 3).

Table 3

Functional and technological characteristics of samples of first-grade «Gerodiietychna» cooked sausage

Parameter	Sample	
	Control	Experiment
Water-binding capacity,%	80.06	82.03
Water-holding capacity,%	60.10	64.25
Emulsifying capacity,%	54.15	55.92
Emulsion stability,%	81.13	82.20
Yield,%	115.30	117.80

Water-binding capacity is an important functional characteristic determining both the sensorial and rheological properties of a product. The water-binding capacity of the test samples was almost 2% higher than that of the control samples. The water-holding capacity of the samples containing oat and amaranth flours was 4.15% higher than that of the control samples. The use of oat and amaranth flours improved the emulsifying properties of the minced meat. The emulsifying capacity of the test samples increased by 1.77% compared to the control samples.

The improved functional and technological properties of the test samples resulted in a 2.5% increase in yield and a savings of up to 12% in raw meat.

The increased water-binding and water-holding capacity of the test cooked sausage samples is likely due to the influence of the plant proteins in oat and amaranth flours, which interact with muscle proteins, promoting moisture retention, thereby improving the functional and technological properties of meat systems.

Based on the research results, a technology was developed for the production of first-grade «Gerodiietychna» cooked sausage. The technology was tested under industrial conditions.

Conclusion. The use of oat flour, amaranth flour, and black caraway in gerodietetic cooked sausage formulations improves the physical and chemical properties (increased protein content, decreased fat content, and energy value) and functional and technological properties (increased water-binding capacity, water-holding capacity, emulsifying capacity and emulsion stability). The results confirm the effectiveness of using plant-based raw materials as important sources of nutrients and biologically active substances that provide the gerodietetic value of meat products, making them a promising option for enriching the diets of elderly persons.

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