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CUT SEMI-FINISHED PRODUCTS WITH THE ADDITION OF BREWER'S GRAINS

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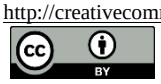

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Abstract. The recipe for minced poultry cutlets was improved by introducing prepared beer grits as a functional ingredient. By replacing part of the traditional fillers (in particular, wheat bread or flour) with grits, a comprehensive assessment of the impact on the nutritional composition, organoleptic properties, texture, taste and consumer acceptability of the product was carried out. It was shown that the use of beer grits allows to significantly enrich the protein product with dietary fiber, B vitamins (in particular, thiamine, riboflavin, niacin) and minerals, which contributes to improving the overall profile of usefulness. Sensory studies involving an expert tasting panel confirmed the high acceptability of recipes with a grit content of up to 30% of the total mass of minced meat. This level provides a rational balance between taste characteristics and textural structure, preserving the traditional qualities of the product, but giving it new features of functional nutrition. Special attention is paid to the biological value of the new ingredient: it is shown that its inclusion contributes to a more complete absorption of essential amino acids, in particular methionine, and prevents excessive formation of homocysteine in the human body, which is an important factor in the prevention of cardiovascular diseases. The study emphasizes the potential of beer grains as a sustainable, environmentally friendly and economically beneficial ingredient for implementation in innovative food products. This approach meets the modern challenges of sustainable development, the concept of waste-free production, as well as global trends in healthy nutrition and functionalization of everyday products. The presented results open up prospects for further research and development in the field of functional meat products using brewing by-products as valuable food resources.

Keywords: Chopped chicken cutlets, protein product, methionine, homocysteine, brewer's grains, dietary fiber, B vitamins.

Introduction. Formulation of the problem

Currently, food technologies are developing in the direction of expanding the range of healthy food products ready for consumption, as this is required by the modern pace of life of the population [1]. Given that consumers are increasingly concerned about their health, the products manufactured must not only have high organoleptic characteristics with minimal time spent on their preparation, but also comply with the principles of healthy eating [1]. Today, scientists are paying great attention to the study of improving the individual characteristics of a food product by adding concentrated food additives [1].

Human health largely depends on a balanced diet. Food industry technologists should take into account innovative research in nutrition, medicine, and nutritional physiology in the technological design of food products.

Protein raw materials are extremely valuable and multifunctional, but without taking into account the synergy of amino acids with other ingredients, they may not be fully absorbed, which will lead to a negative effect in metabolism. In particular, in the process of assimilation of methionine, which is rich in animal products, an intermediate metabolite homocysteine can be formed if the nutrients are unbalanced [2].

For many years, doctors have considered high cholesterol levels to be a major problem, while not paying the necessary attention to such a problem as homocysteine. Homocysteine is a sulfur-containing amino acid that is an intermediate metabolite formed during the breakdown of methionine [2]. Studying various types of raw materials and their importance for healthy nutrition, it was found that the main reason for the deterioration of human health is not so much the presence of cholesterol as the formation of an increased amount of homocysteine in the body, which is formed as a result of the biotransformation of the amino acid methionine, with an insufficient amount of micronutrients. Methionine is ingested from animal products, particularly meat. However, during metabolism, methionine is transformed and homocysteine is formed, which in turn causes Alzheimer's disease, senile dementia, myocardial infarction, thrombosis, heart failure, cerebral atherosclerosis, and atherosclerotic vascular disease. Increased levels of homocysteine in the body are caused

by defects in the enzyme system associated with the synthesis and metabolism of homocysteine, as well as deficiencies in nutrients such as pyridoxine (vitamin B6), folic acid (vitamin B9), and cyanobalamin (vitamin B12) [3]. The presence of these vitamins in the main and auxiliary raw materials will facilitate the absorption of methionine without the risk of homocysteine formation.

The deficit of dietary fiber in the diet of the Ukrainian population reaches 60% [1]. Currently, the development of products with a sufficient content of dietary fiber is underway to eliminate their deficiency in the human diet. Dietary fiber plays a key role in maintaining health and well-being. They are one of the main components of a healthy diet, providing many positive effects on the digestive, cardiovascular and endocrine systems.

Analysis of recent research and publications

There are two main types of dietary fiber: soluble and insoluble [4]. The main sources of soluble dietary fiber are fruits and vegetables [4], and cereals and whole grain products are insoluble [5]. Different plant materials are characterized by the presence of certain dietary fibers [5]. In the gastrointestinal tract, under the influence of the intestinal microbiota, the transformation and conversion of most dietary fibers is more or less intense: fermentation of soluble dietary fibers is usually easier than for insoluble cereals [5].

In water, soluble fibers form a gel-like system that helps reduce cholesterol and glucose levels in the blood. The main sources of soluble fiber are oats, barley, fruits and legumes.

Insoluble fibers, on the other hand, do not dissolve in water and help improve metabolism. They help prevent constipation and support intestinal health. The main sources of insoluble fiber are whole grains, nuts, seeds, and vegetables.

Soluble dietary fiber can lower low-density lipoprotein or “bad” cholesterol, which reduces the risk of cardiovascular disease. They also help regulate blood sugar by slowing the absorption of glucose. This is especially important for people with diabetes or a predisposition to this disease.

According to a number of authors [7, 8, 14], dietary fiber affects the level of homocysteine in the blood and has the following positive properties. They improve intestinal function, contributing to the normalization of its functions and the interaction of amino acids with B vitamins, which promotes better methionine metabolism, and preventing the formation of homocysteine. They improve the synthesis of short-chain fatty acids, which will have a positive effect on the functional activity of the liver, where methionine is metabolized, which will help reduce the accumulation of homocysteine levels.

The presence of antioxidants in the product is also important, as they help reduce oxidative stress, which in turn affects homocysteine levels in the body.

The development of multicomponent formulations of sliced meat products will improve both the organoleptic properties of the products and their digestibility in the human body. As an ingredient in such compositions, it is advisable to use brewer's grains, which are a source of various dietary fibers, vitamins and minerals. In addition, brewer's grains are a secondary product of the brewing industry, which will reduce the cost of the finished product.

The peculiarities of the technological process result in the leaching of soluble carbohydrates from barley wort, leaving solid particles that form the basis of brewer's grains. The latter has significant potential for use as a food additive due to its high content of dietary fiber, protein and minerals. Brewer's grains are a source of dietary fiber, especially viscous fiber, which helps to increase the excretion of cholesterol and fat, reduce blood homocysteine levels, accelerate the passage of food lumps [7] and reduce the symptoms of ulcerative colitis [8]. The inclusion of brewer's grains as an ingredient in the formulation of extruded snacks and breadsticks has also been shown to increase the level of bioactive substances and products with a low glycemic index [6].

Article [15] investigated the possibility of using brewer's grains in the production of protein textures for the meat processing industry. The authors of [15] developed a recipe for a grain-protein texture based on soybean flour, gluten, and brewer's grains. The results showed that the introduction of brewer's grains increases the protein content by 1% and reduces the fat content by 46% compared to traditional textures [15]. The resulting product has a fibrous structure identical to the texture of natural meat and meets the safety requirements of DSTU 4538:2006 [15].

Also, according to a review [16], brewer's grains are a rich source of dietary fiber, proteins, minerals, vitamins, and bioactive compounds with high antioxidant activity. In particular, it contains hydroxycinnamic acids such as ferulic and p-coumaric acids. Studies [16] have shown that the addition of brewer's grains to food products at a concentration of up to 20% can improve their nutritional value without adversely affecting their sensory properties.

The results of a study [17] on the use of beer brewer's grains as a structuring agent in the technology of molded fish semi-finished products showed that the introduction of beer brewer's grains with a particle size of less than 0.73 mm improves water retention, emulsion stability, and reduces weight loss during heat treatment [17].

Study [18] substantiated the development of meat product technologies using vegetable fillers and milk proteins. Researchers [18] studied the possibility of enriching the formulation of semi-finished meat products with whey enriched with magnesium and manganese in order to improve the organoleptic and physicochemical characteristics of the products. The results confirmed the feasibility of using plant additives

to expand the range of meat products with a regulated composition of proteins, fats and biologically active components.

The authors of [19] also studied brewer's grains and showed that they are a rich source of dietary fiber, proteins, and antioxidants, and that their introduction into meat products can improve the nutritional value and functional properties of the finished product. It has been found [19, 20] that the use of brewer's grains in the recipe of Frankfurter sausages increases the content of dietary fiber without adversely affecting the sensory characteristics of the product. The composition of brewer's grains and meat products has a better structure and reduces losses during heat treatment [20].

The Odesa National Technological University studied the possibility of replacing the bread component in the formulations of sliced semi-finished products with vegetable additives. Scientists [21] concluded that when wheat bread is completely replaced in the recipe with a vegetable additive (3 % pumpkin seed fiber + 10 % red lentil flour) (13 %), the following changes occur the raw minced meat becomes dense, acquires an unpleasant brown color, after appropriate heat treatment the color changes to gray, and the finished product has a hard, juicy dense consistency, a strongly flattened shape and a pronounced bean flavor [21]. It has also been found that when the concentration of lentil flour in cut semi-finished products is reduced by less than 10%, the indicators remain unchanged, but the presence of a small proportion of bread reduces bitterness and gives juiciness to the finished product [21].

In addition to traditional products of plant origin, there are also studies on the addition of spirulina to the composition of chopped semi-finished products. It has been found that when spirulina is added, all indicators of model minced systems improve, but the consistency of minced meat becomes denser, which requires adjusting the amount of moisture added during the preparation of minced meat [22].

Based on the results of the studies, it was concluded that replacing up to 3 % of rabbit meat with the microalgae spirulina allows to obtain chopped semi-finished products of good quality; to increase the amount of proteins of plant origin in semi-finished products by 2.8 %; to bring the ratio of proteins of plant and animal origin closer to the recommended one, which makes it possible to increase the degree of assimilation of chopped semi-finished products and classify them as health food products; to enrich chopped semi-finished products with spirulina components, which helps to strengthen the health of the human immune system, to reduce the cost of chopped semi-finished products by reducing the price, by using spirulina in the ratio of 3% to rabbit meat [22].

Purpose and objectives of the study.

Objective: Scientific substantiation of the introduction of beer brewer's grains into the formulation of sliced meat products to improve the nutritional profile and organoleptic characteristics of the finished product.

Key objectives of the research:

1. Conduct an information search to increase the nutritional value of sliced meat products by introducing beer brewer's grains into the recipe.
2. Determine the effect of beer brewer's grains on the texture of chicken cutlets and establish the recommended mass fraction of filler.
3. To establish the balance of the chemical composition of the products enriched with brewer's grains in comparison with the classical recipe.
4. Conduct sensory analysis, compare the results of trial batches with the control recipe.

Research materials and methods

Chopped meat products are in great demand in the restaurant industry. We have improved the recipe of such products in the technology of chicken cutlets. The recipe for classic chicken cutlets from the “Collection of recipes for national dishes and culinary products: for catering establishments of all forms of ownership” was taken as a control [23]. The research was conducted according to generally accepted methods in accordance with the requirements of current technical specifications and state standards. To determine the possibility of using herbal additives in the technology of production of meat cutlets, 4 batches of the tested cutlet samples were made. The control sample was made according to a classical conventional recipe; in the recipe of the test samples, wheat bread was replaced with wet beer brewer's grains in a certain amount, the use of which was due to its valuable properties. For the study, samples of brewer's grains from barley malt were taken immediately after the mashing process during beer brewing.

Table 1 shows the chemical composition of the main ingredients of chicken fillet cutlets [24, 25, 26]

During the experimental studies, a set of research methods used in the culinary industry was used to determine the quality indicators of finished cutlets.

The production of prototypes of chopped poultry cutlets was carried out according to the classic recipe for chicken cutlets from the “Collection of recipes for national dishes and culinary products: for catering enterprises of all forms of ownership” [23]. The classic recipe for chopped semi-finished products contains up to 20 % wheat bread. In accordance with the purpose of the study, wheat bread was completely replaced with brewer's grains. During the research, the organoleptic properties and chemical composition of the sliced semi-finished products were determined according to generally accepted methods. Thus, when analyzing the results obtained, we were guided by the requirements of the regulatory documentation DSTU 4437:2005 "Semi-finished meat and vegetable cut products. Technical specifications".

The quality of minced meat and the finished product was assessed based on the results of organoleptic evaluation.

Table 1 - Chemical composition of the main ingredients of chicken cutlets, g (mg)/100 g

№	Component	Chicken fillet	Wheat bread (moistened)	Beer brewer's grains (moist)
1	Dry matter, g	26,0	32,0	25,0
2	Proteins, g	22,5	4,1	8,5
3	Lipids, g	2,0	1,5	2,5
4	Carbohydrates, g	-	25,0	-
5	Ash, g	1,0	0,7	1,0
6	Dietary fiber, g	-	-	13,0
7	Phosphorus, mg	180,0	43,0	0,48 g
8	Potassium, mg	250,0	60,0	0,16
9	Magnesium, mg	25,0	11,0	-
10	Calcium, mg	13,0	17,0	8,2
11	Sodium, mg	60,0	250,0	-
12	Iron, mg	0,9	0,7	21,0
13	Zinc, mg	0,9	0,3	6,7
14	Copper, mg	0,07	0,05	-
15	Manganese, mg	0,02	0,17	3,4
16	Selenium, mcg	20,0	-	
17	Vitamin B1, mg	0,06	0,2	23,85
18	Vitamin B2, mg	0,13	0,06	0,31
19	Vitamin B3, mg	12,0	1,2	-
20	Vitamin B5, mg	1,5	-	-
21	Vitamin B mcg	0,06	0,07	0,49
22	Vitamin B12 mcg	7,0	23,0	-
23	Vitamin E, mg	0,4	-	-
24	Vitamin K, mcg	0,3	0,2	-
25	Proline, g	-	0,3	0,45
26	Glutamic acid, g	-	-	0,035
27	Linoleic acid (Omega 6), g	3,5	-	0,034
28	Palmitic acid, g	-	-	0,045
29	Oleic acid	-	-	0,18
30	(Omega 3), g	-	-	0,004
31	Leucine, g	1,7	-	-
32	Isoleucine, g	1,0	-	-
33	Valine, g	1,0	-	-
34	Lysine, g	1,9	-	-
35	Threonine, g	1,0	-	-
36	Phenylalanine, g	0,9	-	-
37	Methionine, g	0,6	-	-
38	Tryptophan, g	0,25	-	-
39	Aspartic acid, g	2,2	-	-

The organoleptic characteristics of chopped cutlets were determined in accordance with DSTU 4436:2005 "Semi-finished meat and vegetable cutlets. Technical specifications“, DSTU 4823.2:2007 ”Meat products“ and DSTU 7345:2021 ”Brewing grains. Technical specifications". The organoleptic characteristics of the experimental samples were determined by the profile method using a five-point scale, and the results of the sensory evaluation were additionally shown using profilograms. During the organoleptic study, the appearance, shape, color, smell, and cut appearance of the raw semi-finished product were checked. After heat treatment, the taste, aroma and juiciness of the finished products were evaluated. The weight of the cutlets was controlled by weighing. The permissible deviation of the weight of one product was ± 3 %. Statistical data processing was performed using the Microsoft Excel software package.

Results of the research and their discussion

Classic chicken cutlets were chosen for the study because poultry meat is easier for the body to digest than pork and cattle meat. The control sample of chopped chicken cutlets contains up to 20% wheat bread. In accordance with the purpose of the study, wheat bread was completely replaced with brewer's grain. Based on the content of protein, vitamins and dietary fiber in the brewer's grains, the optimal amount of brewer's grains added to the minced meat was selected, namely: 40%, 30%, and 20% of the crushed meat by weight of the total minced meat. For better perception, the recipe models are presented in Table 2. The chemical composition of each sample was investigated by calculation. The data are shown in Table 3.

Taking into account the information presented in Table 3, we can see that the introduction of beer brewer's grains into the chicken cutlets recipe makes it possible to enrich the final product with dietary fiber, protein and vitamins. Based on a comparative analysis of the chemical composition of the control sample and the experimental samples of chicken cutlets with the addition of beer brewer's grains (Samples 1-3) in relation to the daily human need for these components, we can see that all samples retain a high protein content (15.0-18.0 g/100 g), which is approximately 20-28% of the daily human need. The addition of brewer's grains increases the content of dietary fiber (1-1.6 g vs. 0.4 g in the control) in the finished product.

The highest performance is in Sample №1, where the content of brewer's grains is 400 g. This helps to improve the digestion process in the gastrointestinal tract.

There is a slight decrease in the content of B vitamins (B1, B2, B3, B5, B6, B9, B12) in the test samples compared to the control sample, especially in Samples №2 and №3. These values are not critically low, they average 5-15% of the daily requirement per 100 g of product, which should be taken into account when formulating a complete diet.

All the samples have comparable levels of macro- and microelements (potassium, calcium, magnesium, phosphorus, iron, zinc, selenium). However, the overall mineral profile remains satisfactory. The organoleptic evaluation was carried out with the involvement of a group of 5 tasters. Based on the average results of the group's readings, sensory profiles were compiled for three samples.

The generalized organoleptic indicators are presented in Table 4.

Table 2 - Recipe models of chicken cutlets with the addition of beer brewer's grains for the study

№	Indicator	Control sample	Sample №1	Sample №2	Sample №3
1	Ratio of components	0.5 : 0.2 : 0.05	0.5 : 0.4	0.5 : 0.3	0.5 : 0.2
2	Amount of meat, g	500.0	500.0	500.0	500.0
3	Amount of wheat bread, g	200.0	No addition	No addition	No addition
4	Amount of brewer's grains, g	No addition	400.0	300.0	200.0
5	Amount of water, ml	50.0	-	-	-
6	Type of grains	-	Moist	Moist	Moist
7	Processing of grains	-	Cooking for 40-50 min at 95-98°C, grinding in a blender		
8	Processing of meat	Grinded in a meat grinder			
9	Formation of semi-finished products	Cutlets, 100 g	Cutlets, 100 g	Cutlets, 100 g	Cutlets, 100 g
10	Heat treatment	Combi-steamer, 150°C, 35-40 min	Combi-steamer, 150°C, 35-40 min	Combi-steamer, 150°C, 35-40 min	Combi-steamer, 150°C, 35-40 min
11	Amount of additives, % of total weight of minced meat	20%	40%	30%	20%

Table 3 - Nutrient content of the test samples compared to the daily requirement and the control sample

№ п/п	Component	Control sample, g/100 g	Sample No.1, g/100 g	Sample No.2, g/100 g	Sample No.3 g/100 g	Organismal requirements
1	Dry matter, g	24,94	19,44	20,31	21,43	-
2	Proteins, g	16,4	17,86	16,25	15,0	80,0
3	Lipids, g	1,71	1,86	1,81	1,78	90,0
4	Carbohydrates, g	6,67	1,78	1,5	1,14	350,0
5	Ash, g	0,85	1,44	1,38	1,29	20,0
6	Dietary fiber, g	0,4	1,56	1,31	1,0	35,0
7	Phosphorus, mg	156,0	172,86	161,25	152,22	700,0-1250,0
8	Potassium, mg	197,33	217,14	205,0	195,56	2500,0–3500,0
9	Magnesium, mg	23,33	41,67	39,38	36,43	300,0–400,0
10	Calcium, mg	14,67	28,89	26,25	22,86	800,0–1200,0
11	Sodium, mg	113,33	50,86	44,88	40,22	< 2000,0
12	Iron, mg	1,0	1,03	1,01	0,99	8,0–18,0
13	Zinc, mg	0,8	0,96	0,96	0,97	8,0–14,0
14	Copper, mg	0,05	0,11	0,10	0,09	0,9–1,5
15	Manganese, mg	0,09	0,12	0,11	0,09	2,0–5,0
16	Selenium, mcg	13,33	19,86	17,62	15,89	55,0–75,0
17	Vitamin B1, mg	0,06	0,11	0,10	0,09	1,1–1,5
18	Vitamin B2, mg	0,07	0,09	0,09	0,09	1,1-1,6
19	Vitamin B3, mg	8,32	9,03	8,1	7,38	14,0–18,0
20	Vitamin B5, mg	0,81	0,93	0,88	0,83	5,0
21	Vitamin B mcg	0,35	0,41	0,39	0,37	1,3–2,0
22	Vitamin B12 mcg	5,33	7,56	7,0	6,29	400,0
23	Vitamin E, mg	0,2	0,21	0,19	0,17	2,4–3,0
24	Vitamin K, mcg	0,23	0,27	0,26	0,26	10,0–15,0
25	Proline, g	0,03	0,04	0,04	0,03	90,0–120,0
26	Glutamic acid, g	0,75	0,77	0,7	0,64	~3,0–4,0
27	Linoleic acid (Omega 6), g	2,93	2,89	2,6	2,38	~8,0–10,0
28	Palmitic acid, g	0,32	0,31	0,29	0,27	10,0-17,0
29	Oleic acid	0,34	0,35	0,32	0,29	< 10,0
30	(Omega 3), g	0,43	0,47	0,43	0,4	20,0–30,0
31	Leucine, g	1,24	1,3	1,18	1,08	4,0-5,0
32	Isoleucine, g	0,72	0,77	0,7	0,64	2,0-3,0
33	Valine, g	0,75	0,79	0,72	0,67	3,0-4,0
34	Lysine, g	1,25	1,34	1,2	1,09	3,0-4,0
35	Threonine, g	0,64	0,67	0,6	0,54	1,5-2,5
36	Phenylalanine, g	0,59	0,61	0,56	0,51	2,0-3,0
37	Methionine, g	0,43	0,44	0,39	0,36	1,0-2,0
38	Tryptophan, g	0,15	0,15	0,14	0,12	0,25-0,5
39	Aspartic acid, g	1,68	1,71	1,56	1,44	6,0-7,0

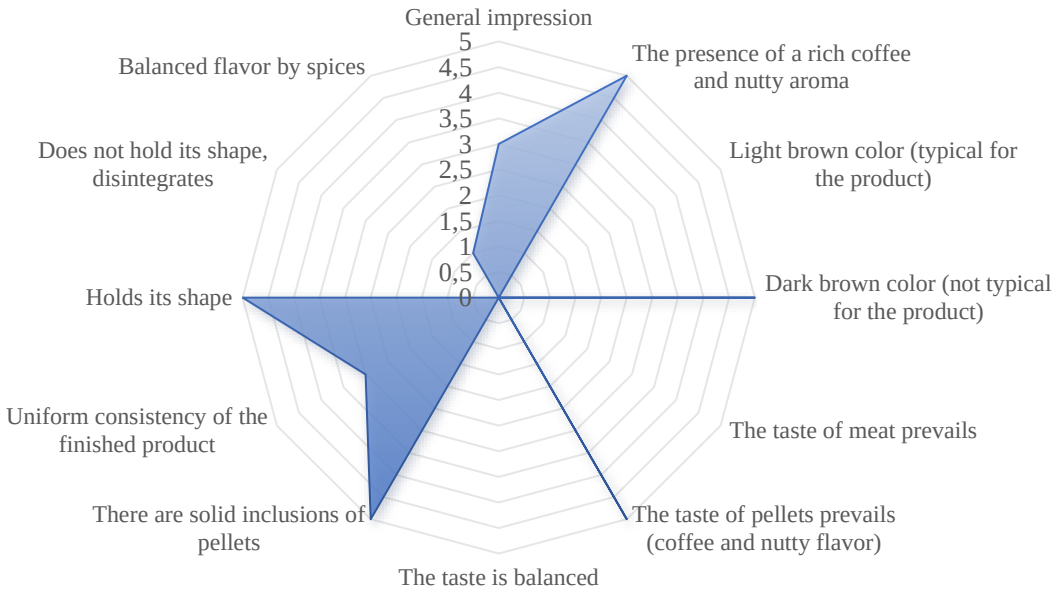

Fig. 1 - Sensory profile of chicken cutlets with the addition of 40% beer lees

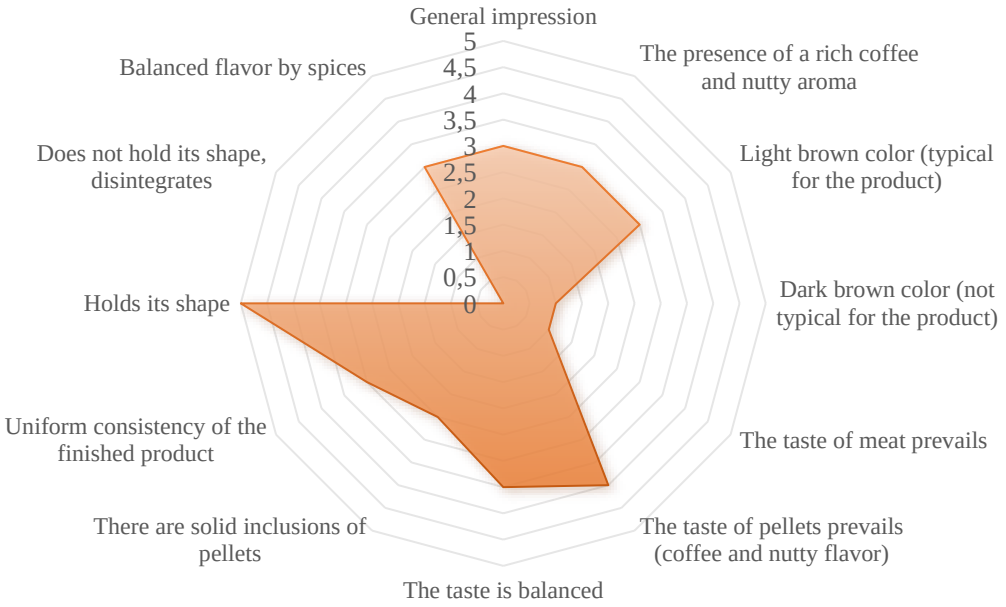

Fig. 2 - Sensory profile of chicken cutlets with the addition of 30% beer lees

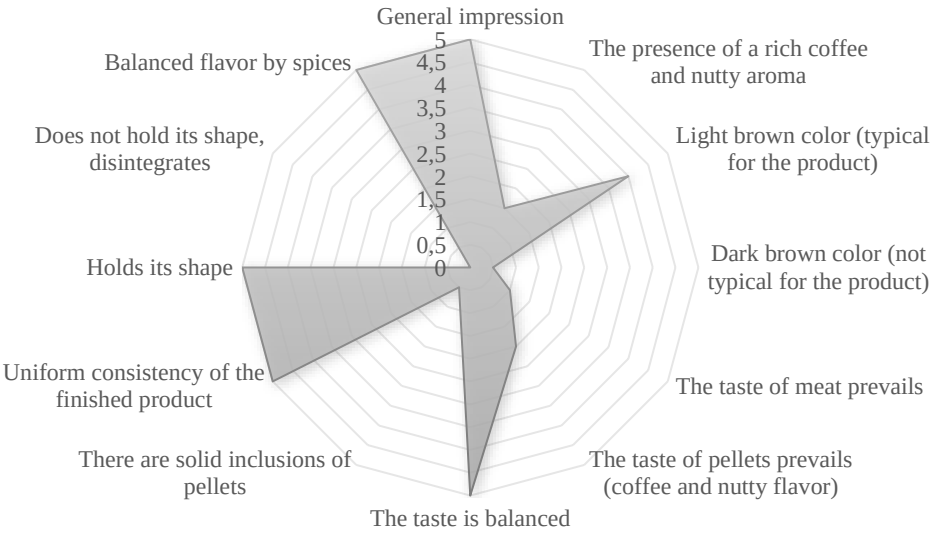

Fig. 3 - Sensory profile of chicken cutlets with the addition of brewer's grains in the amount of 20% of the additive

Table 4 - Organoleptic indicators of chicken cutlets with the addition of beer lees

№	Name	Meaning
1	Fractional content 40%	The aroma is too strong, with predominant notes of coffee and nuts, which are not characteristic of traditional meat products. The taste of beer grits is pronounced, with solid particles present. The product holds its shape and does not crumble. The color is too dark, which is not typical for chicken cutlets. The addition of 40% beer grits to the recipe led to negative changes in the sensory properties of the finished product.
2	Fractional content 30%	The aroma is pleasant, with a moderate malt flavor. There is a noticeable flavor of pellets, but it is less intense than in sample №1. Solid particles are present, but in small quantities. The product does not crumble. The color is dark brown, not typical for chicken cutlets. Reducing the amount of pellets improves the taste of the finished product, but the presence of impurities is still noticeable.
3	Fractional content 20%	The aroma is pleasant, with a light malt hue, balanced aroma of meat and beer brewer's grains. The flavor of the pellet is distantly felt, without dominance. There are no solid particles. The consistency is homogeneous, the product holds its shape well. The color is typical for chicken cutlets. The optimal ratio of meat raw materials and brewer's grains in the amount of 20% improves the structure of the finished product without compromising the taste and visual properties of the cutlets.

So, taking into account the functional, technological and organoleptic properties of different samples, it was found that before adding brewer's grains to dishes, they should be pre-boiled for 40-50 minutes and then grinded in a blender. This makes the raw material softer and more homogeneous, so that no solid particles are felt in the cutlets and this does not affect the taste of the product. The optimal amount of pellets to add to minced meat is 30% by weight of meat. The technological scheme of cooking chicken cutlets with the addition of beer brewer's grains is shown in Fig. 4

Conclusion

The inclusion of beer brewer's grains in chicken cutlets leads to a noticeable densification of the texture and improvement of the structural integrity of the product.

According to the results of the information search, it was found that the use of brewing by-products, in particular beer brewer's grains, is a promising area in the meat processing industry. Brewer's grains have a high nutritional value due to the content of proteins, fiber, B vitamins and minerals, which allows enriching meat products with valuable nutrients, increasing their biological value and improving environmental safety of production.

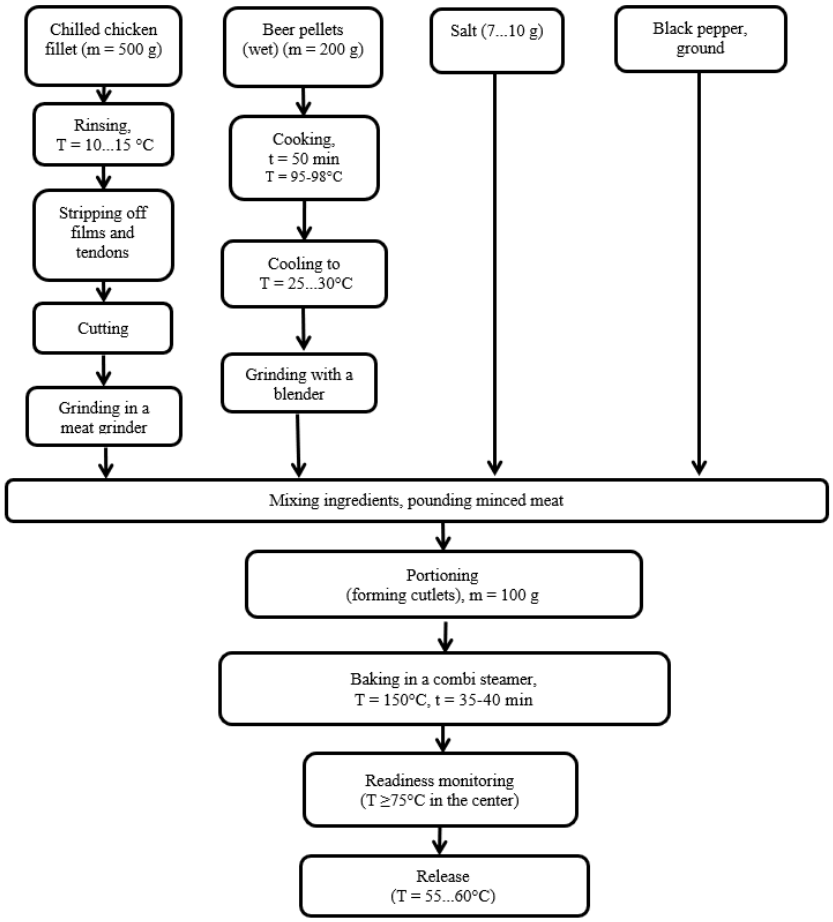

Fig. 4 - Technological scheme of cooking chicken cutlets with the addition of beer pellets

Studies of the effect of beer brewer's grains on the texture of chicken cutlets have shown that the introduction of 20% of the filler has a positive effect on the consistency of the products, improves their juiciness and plasticity. When the mass fraction increases above 20%, there is a deterioration in textural characteristics - the products become less homogeneous and excessively dense. The optimal recommended mass fraction of brewer's grains is 20 %.

The analysis of the chemical composition of products enriched with brewer's grains showed an improvement in the balance of basic nutrients compared to the classical recipe. In particular, there was an increase in the content of dietary fiber, vegetable protein, as well as B vitamins and minerals. When combined with other foods, these cutlets can provide a full intake of B vitamins, protein and trace elements in the body. This allows us to recommend such products to expand the range of functional meat products.

The sensory analysis confirmed that patties with up to 20% brewer's grains were as good as the control sample in terms of taste. On the other hand, products with a higher content of brewer's grains (30-40%) received lower scores for taste and texture due to excessive density, tangibility of solid particles of brewer's grains, and dominance of the malt flavor.

Thus, the inclusion of brewer's grains in the recipe for chicken cutlets is a scientifically and technologically sound method of increasing the nutritional value of the products. The use of 20 % brewer's grains allows to create a balanced, functional meat product with improved organoleptic and nutritional properties. .

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СІЧЕНІ НАПІВФАБРИКАТИ З ДОДАВАННЯМ ПИВНОЇ ДРОБИНИ

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Анотація. Удосконалено рецептуру січених котлет з м'яса птиці шляхом уведення підготовленої пивної дробини як функціонального інгредієнта. Замінивши частину традиційних наповнювачів (зокрема, пшеничного хліба або борошна) на дробину, здійснено всебічну оцінку впливу на поживний склад, органолептичні властивості, текстуру, смак і прийнятність продукту споживачем. Показано, що використання пивної дробини дозволяє суттєво збагатити білковий продукт на харчові волокна, вітаміни групи В (зокрема тіамін, рибофлавін, ніацин) та мінеральні речовини, що сприяє покращенню загального профілю корисності. Сенсорні дослідження із залученням експертної дегустаційної панелі підтвердили високу прийнятність рецептур із вмістом дробини до 30% від загальної маси фаршу. Такий рівень забезпечує раціональний баланс між смаковими характеристиками та текстурною структурою, зберігаючи традиційні

якості продукту, але надаючи йому нові ознаки функціонального харчування. Окрему увагу приділено біологічній цінності нового інгредієнта: показано, що його включення сприяє більш повному засвоєнню незамінних амінокислот, зокрема метіоніну, та запобігає надмірному утворенню гомоцистеїну в організмі людини, що є важливим чинником у профілактиці серцево-судинних захворювань. Дослідження підкреслює потенціал пивної дробини як стійкого, екологічно доцільного та економічно вигідного інгредієнта для впровадження в інноваційні харчові продукти. Такий підхід відповідає сучасним викликам сталого розвитку, концепції безвідходного виробництва, а також глобальним тенденціям здорового харчування та функціоналізації продуктів щоденного споживання. Представлені результати відкривають перспективи для подальших досліджень і розробок у галузі функціональних м'ясних виробів із використанням побічних продуктів пивоваріння як цінних харчових ресурсів.

Ключові слова: котлети рубані курячі, білковий продукт, метіонін, гомоцистеїн, пивна дробина, харчові волокна, вітаміни групи В.