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Quality investigation of meat-and-vegetable chopped semi-products based on turkey meat and champignon mushrooms

Azarova N., Shlapak N., Harbazhiy K.

Odessa National Academy of Food Technologies

E-mail:karinafurmuk@gmail.com

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The aim of the current work was to develop a recipe of meat-and-vegetable chopped semi-products of the new generation based on turkey meat and champignon mushrooms and to investigate its quality. The samples of turkey meat with the addition of champignon mushroom mass were prepared and studied. Physical chemical methods including determination of the mass fraction of moisture, water-retaining ability, weight losses during heat treatment, determination of maximum shear stress and the content of sodium chloride. The organoleptic analysis was based on identification of taste, odor, consistence and view on the cut and were used in order to characterize the quality of new semi-products from turkey meat and champignon mushrooms. Studies have shown that the addition of mushroom mass to model minced meat from turkeys lead to an increase in the mass fraction of moisture in the samples, as the moisture content of the mushroom is greater than in turkey meat. The water-retaining ability in the model samples is reduced, which is associated with an increase in moisture in the specimens with adding of mushroom mass. The consistency of the specimens was determined by a penetrometer using a conic cone. It was determined that the consistency of the model samples with the addition of mushroom mass become softer. The pH of the sample forcemeat significantly did not change. Analysis of the data that has been obtained showed that the addition of mushroom mass leads to the destruction of meat parsley systems and reduce their functional and technological properties. Based on the results of the research, it was concluded that the most rational way is to replace up to 3 % of the turkey meat with the mass of champignon mushroom without the practical reduction of the organoleptic parameters in the formulation of the cut semi-finished products.

Key words: turkey meat, mushroom, champignon, cutlets, semi-products, functional and technological properties.

Problem statement and analysis of recent research. Unbalanced nutrition leads to the emergence of various diseases, which deepen in the background of high loads of industrial activity, the level of stress, the deterioration of the ecological situation, social problems, and others. Therefore, the development of technologies, on the basis of which food products of modern direction are formed, is relevant in the food industry.

Nowadays turkey meat has great interest in the production of health food products. It is one of most consumed poultry meat due to dietary properties come through a poorly developed connective tissue and a small amount of fat in the muscle tissue [1] but has a higher cost than chicken meat [2, 3]. Turkey meat is very useful, as it contains high-grade protein substances (21,6%), moderate amounts of lipids (12,0%), small amount of cholesterol (0,13) and different vitamins including A, E, B2, B12, PP, B6 [4-6].

Additionally, there are trends aimed at increasing the consumer properties of food products in the field of improving the structure of food. One of such direction is the energy balance of a diet and the use of products that have easy digestion [7]. For rational nutrition the development of meat products that will fully meet human requirements is necessary, but for this purpose both traditional and non-traditional types of raw materials should be used. As known, the ratio of proteins of animal and vegetable origin, which is recommended, should be as 55:45 %, respectively [8, 9]. There-

fore, in order to increase the consumer properties of chopped semi-finished products from turkey meat, the possibility of using edible mushrooms in their formulation as a source of vegetable protein was studied.

The intensive development of industrial production of edible mushrooms in Ukraine is due to a number of important factors including [10]:

- the use for the cultivation of substrates made of accessible materials;
- high productivity (one hectare can be collected per a year about 800 tons of mushrooms, which is 2.4 tons of complete protein);
- the possibility of use for cultivation of mushrooms, except for special, other premises that are not used for their intended purpose (warehouses, cellars, etc.);
- the opportunity of a year-round harvest, which makes it possible to eliminate seasonality in the supply of mushroom products;
- technology of mushroom growing is ecologically clean and non-waste, because the substrate after cultivation of mushroom can be used as a valuable fertilizer.

The industrial production of edible mushrooms also has a number of health and environmental benefits. The substances produced by many cultivated mushrooms have anti-sclerotic and antioxidant effects, which can increase immunity to viral diseases and reduce the harmful effects of radiation physiotherapy [11-13].

The most cultivated mushrooms in Ukraine are champignons accounted 90 % of total number of mushrooms [14], the chemical and organoleptic compositions of which were investigated by scientists [15-17]. Champignon mushrooms have more protein substances and a low-calorie content of 27 kcal compared to 33 kcal of oyster mushrooms, which is the main reason for their use in preparation of semi-products.

The aim of the research. The aim of the current work was to develop a recipe of meat-and-vegetable chopped semi-products of the new generation based on turkey meat and champignon mushrooms and to investigate its quality. Due to the lack of information about the addition of mushroom mass to turkey meat in order to get forcemeat investigations about meat-and-vegetable chopped semi-products this work is relevant. We used mushrooms as an innovative raw material in the composition in production of cutlets, which justifies scientific novelty stated in this article.

Material and methods of research. *Preparation of raw materials.* The samples of turkey meat with the addition of champignon mushrooms (in the form of mushroom mass) were prepared and studied. The meat, after visual inspection, was chopped by a top-chopper with a diameter of 2-3 mm. Champignon mushrooms after visual inspection and clean, were thoroughly washed with warm water and, after draining of moisture, were crushed using crush machine Moulinex ME 442TD (France) to a size of 2-3 mm to obtain the mushroom mass (MM). In samples of chopped meat, presented in the mushroom mass (except control) was added from 0 to 5 % at an interval of 1. Adding mushroom mass more than 4 % significantly reduces the water-retaining ability of minced meat and increases the losses during heat treatment, which will reduce the quality of semi-finished products.

Preparation of components of minced meat.

Preparation of components of minced meat included the following:

- defrosting the melange in a bath with water at a temperature not exceeding 45 °C, control its quality, weighing of the required amount according to the recipe;
- salt: control of its quality, sifting, weighing the required amount according to the recipe;
- black pepper: control its quality, weighing the right amount according to the recipe;
- rusk flour: control of its quality, sifting, weighing the required amount according to the recipe.

Preparation of minced meat. The minced meat mixer was used to form minced meat. Prepared ingredients according to the recipe were added in the following sequence: minced meat, mushroom mass, bread, mélange, pepper and salt. Mixing was carried out for 4-5 minutes to evenly distribute the structural constituents by volume of minced meat. The final temperature of the stuffing must not exceed 12 °C. After accurate mixing, the samples were kept for 10 minutes for the redistribution of constituents throughout the volume of minced meat. Then the dosing and formation of cutlets from minced meat and laying them in the tray was carried out. Cutlets can be stored at 0-2 °C for no more than 6 hours.

Physical chemical methods.

1. *Determination of the mass fraction of moisture* was conducted using generally accepted method [18]. Quantity of product at 3 g was weighed with an accuracy of 0,002 g and placed into a pre-weighed and dried to constant weight weighing bottle with sand (5-10 g) and a glass rod. Then this weighing bottle was moved to moisture-testing oven 2 B1-51 (Ukraine) for 1 hour at a temperature of 150 °C. After drying, weighing bottle with product was closed with lids and cooled in a desiccator, and then it was weighed.

The moisture content (W) is calculated by the formula:

$$W = \frac{m_1 - m_2}{(m_1 - m_0)} \cdot 100, \% \quad (1)$$

where m_1- the mass of the weighing bottle with product quantity to drying, g;

m_2 - the mass of the weighing bottle with product quantity after drying, g;

m_0 - the mass of the weighing bottle with sand and a glass rod (without product quantity), g.

2. *Determination of water-retaining ability* was carried out according to method outlined by Grau [19]. For this, the crushed quantity of product with 0,3 g were covered with filter paper and placed between two glass plates (80 * 80) mm, from above put a load of 1 kg for 10 minutes. After pressing, the contour of the spots on the filter around the pressed product was noted and dried the filter in the air. The area of the formed spots was measured by a planimeter in cm². The content of bound moisture in the examined sample of the product is calculated according to the formula:

$$B = \frac{(A-k)*B}{M} \cdot 100, \% \quad (2)$$

where A - mass fraction of moisture in quantity, mg;

K - the moisture content of 1 cm² of wet spot, mg (K = 8.4);

B - area of wet spot, cm², (the difference between the total area of the entire stain and the area of the spot, which was formed by the pressed product);

M - the mass of the test product, mg.

3. *Determination of weight losses during heat treatment*

Weighed sample was cooking in water at temperature 80-85 °C to a temperature in the center of the sample of 72 °C. Then it was weighed. The losses in heat treatment (V) are determined by the formula:

$$V = \frac{(m_1 - m_2)}{m_1} \cdot 100, \% \quad (3)$$

where m_1- sample mass before processing, g;

m_2 - sample mass after heat treatment, g.

4. *Determination of pH*

To the quantity of the sample 10 g was added 50 ml of distilled water, mix with a glass rod for 25 minutes and filtered through a folded filter. The pH was determined on the pH-meter Testo 205 (Germany).

5. *Determination of the content of sodium chloride* was provided titration of chloride ions of silver ion in a neutral medium in the presence of potassium chromate as indicator.

The content of sodium chloride is calculated according to the formula:

$$K = \frac{0,00292*v*k*100}{v_1 \cdot m}, \% \quad (4)$$

where 0,00292 – the amount of sodium chloride, equivalent to 1 cm³ 0,05 mol / L solution of silver nitrate, g;

V– the amount of 0.05 mol / L solution of silver nitrate, which is spent on titration of the analyzed solution, cm³;

100 – volume of dilution, cm³;

K – coefficient of correction for a titer of 0.05 mol /L of silver nitric acid solution;

V_1- volume of filtrate taken for titration, cm³;

m – mass of sample product, g.

6. *Determination of maximum shear stress (GNS)*

The main purpose of GNS determination is to determine the consistency of the product. The product for the sample is placed in a mold and level the surface with a spatula.

The device qualimeter with a conical identifier with an angle of 30 at the apex is connected to the mains, put on the subject form prepared sample of the product and measure the depth of immersion of the cone according to the instructions. GNS values are determined by the formula:

$$Q = \frac{k \cdot m}{H^2}, \text{ kPa} \quad (5)$$

where k - the cone constant that depends on the angle at its apex;

m is the mass of the cone with the bar and additional load, kg;

h - depth of immersion of the cone, m.

Determination of organoleptic parameters was based on 9-point system: 9- quality is optimal; 8 – quality is very good; 7 - quality is good; 6 - quality is accepted; 5 - quality is average; 4 - quality is undesirable; 3 - quality is negative.

Organoleptic properties were studied by 6 experts using national standard of Ukraine DSTU 4437:2005 Chopped meat and meat-and-vegetable semi-products. Product appearance was determined by the state of the surface of the product, the presence of a broken edge and the uniformity of panning. Odor was defined immediately after the surface cut. Color was determined by visual inspection on the fresh cut. Taste of product in a cooled state was detected. View on the cut was determined by visual inspection on the fresh cut of product. Consistence was identified by light pressing on a fresh cut of the product.

Research results and discussion. The influence of mushroom addition to turkey meat on change of its physical chemical qualities is shown in Table 1.

Table 1 – **The impact of mushroom mass from champignons on functional and technological properties of model forcemeat systems of turkey meat**

Parameter	Mass fraction of mushroom mass, %					
	Control	1	2	3	4	5
Mass fraction of moisture, %	71,2	72,0	73,6	76,0	79,3	83,4
Water-retaining ability, %	65,5	65,0	64,6	63,9	63,0	61,6
Maximum shear stress, kPa	812,2	808,1	800,5	793,4	791,3	784,6
Weight losses during heat treatment, %.	17,9	18,4	19,0	19,5	20,2	20,8
pH of forcemeat	5,80	5,81	5,83	5,86	5,86	5,87

Investigations showed that adding of mushroom mass to model samples led to increasing of mass fraction of moisture in these samples because mushroom mass contain more water (81,2 %) than turkey meat (71,2 %) (Table 1). Water-retaining ability in model samples reduced associated with increasing of mass fraction of moisture in these samples. Increasing of mass fraction of moisture in model samples with adding of mushroom mass led to softening their consistency and reducing the shear stress. Reducing of water-retaining ability in model samples contributed to increase the loss of mass of minced meat during heat treatment.

Studies have shown that the addition of mushroom mass to model minced meat from turkeys lead to an increase in the mass fraction of moisture in the samples, as the moisture content of the mushroom is greater than in turkey meat. The water-retaining ability in the model samples is reduced, which is associated with an increase in moisture in the specimens with adding of mushroom mass. The consistency of the specimens was determined by a penetrometer using a conic cone. It was determined that the consistency of the model samples with the addition of mushroom mass become softer. The pH of the sample forcemeat significantly did not change: from 5,80 to 5,87.

Analysis of the data that has been obtained showed that the addition of mushroom mass leads to the destruction of meat parsley systems and reduce their functional and technological properties. The value of the maximum permissible amount of mushroom mass from champignons, which may be added to ground meat from turkey meat, was determined by changing the organoleptic characteristics of finished semi-finished products (table 2). For this purpose, control and experimental samples of semi-finished products based on the recipes of the cutlets were prepared. In experimental samples, the meat was changed to 1 to 5 % by weight in mushroom mass in step 1 and then organoleptic parameters of it were determined.

According to data presented in table 1 the highest score was belonged to the first sample, it was the control sample without adding of mushroom mass. Without a significant decrease of organoleptic parameters, no more than 3 % mushroom mass to the forcemeat in order to get semi-finished products with good quality is rationally added. Adding more than 3 % mushroom mass with using the food additives to increase of water-retaining ability of forcemeat and its consistency is recommended.

On the basis of the results of the research, it was concluded that the most rational way is to replace up to 3 % of the turkey meat with the mass of champignon mushroom without the practical reduction of the organoleptic parameters in the formulation of cut semi-finished products.

According to the research results, the recipe for chopped semi-finished products was developed named «Turkey meat special cutlets» (table 3).

Table 2 – **Organoleptic parameters of semi-finished product samples**

№ sample	Amount of mushroom mass, %	Visual appearance	Color	Odor	Taste	Consistency	Succulence	Total score
1	0	8	8	8	7	8	8	7,8
2	1	8	7	7	7	8	8	7,5
3	2	7	7	7	7	8	7	7,3
4	3	7	7	7	7	7	7	7,0
5	4	7	7	7	6	6	6	6,8
6	5	7	6	6	5	6	6	6,5

Table 3– **Recipe of «Turkey meat special cutlets»**

Type of raw products	Raw products mass, g (100 g of cutlets)
1. Meat of turkeys	60,14
2. Mushroom mass	1,86
3. Bread of wheat flour	14,0
4. Melange (broken-out shell eggs)	4,0
5. Salt	1,2
6. Pepper black	0,1
7. Rusk flour	4,0
8. Drinking water	14,7

The mushroom mass contains proteins (about 22 %), which are involved in the most important functions of the body. The addition of wheat bread allowed getting the cutlets with a softer consistency and increasing the amount of protein of vegetable origin [20-22]. Melange is binding material between the components of minced meat for cutlets and it is a source of animal protein and essential fatty acids [23, 24]. Salt and pepper black were used for taste and aroma of cutlets.

The quality of chopped semi-finished products was determined on the basis of organoleptic and physical chemical parameters and compared them with the requirements of the normative and technical documentation (table 4).

The comparative characteristics of the control and test samples we can note the following differences: the raw test specimens are lighter in color, the fried cutlets have a pleasant taste with a light mushroom aroma and a taste, the mass fraction of moisture is less than one of the control sample, the mass fraction of salt and bread is almost indistinguishable from the control sample.

Conclusions

The recipe of meat-and-vegetable chopped semi-products based on turkey meat and champignon mushrooms was developed that allow to reduce the cost of products while increasing their consumption properties. Also the increase of the number of vegetable proteins in meat semi-finished products allows approximating the ratio of protein of plant and animal origin, which is recommended for health nutrition.

According to the results of the conducted research, it was concluded that the replacement of 3 % of turkey meat by weight on champignon mushrooms allows to:

Table 4 – **The physical chemical and organoleptic attributes of control and investigated semi-finished products**

Parameter	Sample characteristics	
	Control (Ukrainian standard 4437:2005)	investigated
1.Visual appearance	The shape of the forcemeat is oval, the surface is uniformly panned, without broken edges	
2. View on the cut	The ingredients of the minced meat are well mixed	
3. Color	*Raw semi-finished products:*	
	pink	light pink
4. Odor and taste	*Raw semi-finished products:*	
	The odor is peculiar for good quality products.	
	Fried semi-finished products:	
	Palatable	Palatable with light mushroom after taste
5. Consistency	*Fried semi-finished products:* succulence	
6. Mass fraction,% no more: - moisture - bread based on bread crumbs - salt in raw semi-finished products	 66 : 18 ; 1,2 – 1,5 :	 65,8 17,2 1,4

- obtain chopped semi-finished products with good quality;
- increase the amount of plant proteins by 2,6 %;
- approximate the ratio of proteins of vegetable and animal origin in semi-finished products to the recommendation, which makes it possible to classify chopped semi-finished products for health food;
- reduce the cost of semi-finished products at the expense of the lowest price of champignon mushrooms in relation to turkey meat.

Further research may be focused on storage of semi-finished products in a frozen state for the purpose of continuation shelf life without reducing their quality, the use of minced meat and vegetable semi-finished products as fillings for dumplings and ravioli, with the establishment of their shelf life and change in quality, the use of minced meat according to the developed recipe of semi-finished products for the production of culinary products.

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Дослідження якості м'ясо-овочевих рублених напівфабрикатів на основі м'яса індички та грибів печериць

Азарова Н. Г., Шлапак Н. В., Гарбажій К. С.

Метою роботи було розроблення рецептури м'ясорослинних посічених напівфабрикатів нового покоління на основі м'яса індички та грибів печериць і дослідження їх якості. Було приготовано і вивчено зразки м'яса індички з додаванням печериць (у вигляді грибної маси). У ході дослідження було використано фізико-хімічні методи, зокрема визначення масової частки вологи, визначення водозв'язувальної здатності, визначення втрати маси за термооброблення, визначення максимальної напруги зсуву і вмісту хлориду натрію, а також органолептичний аналіз на основі визначення смаку, запаху, консистенції і виду на зрізі для визначення якості нових напівфабрикатів з м'яса індички і печериць. Дослідження довели, що додавання грибної маси в модельні фарші з м'яса індиків призводить до збільшення масової частки вологи у зразках, оскільки у грибної маси вологи більше, ніж у м'ясі індиків. Водозв'язувальна здатність у модельних зразках знижується, що пов'язано зі збільшенням вологи в зразках за додавання грибної маси печериць. Зниження водозв'язувальної здатності спричиняє збільшення втрат маси фаршу за термооброблення. Було визначено, що консистенція модельних зразків за додавання грибної маси печериць пом'якшується. Водночас pH фаршу дослідних зразків майже ні змінюється: з 5,80 до 5,87. За даними аналізу додавання грибної маси призводить до руйнування м'ясних фаршових систем і зниження їх функціонально-технологічних властивостей. За результатами досліджень було зроблено висновок, що найбільш раціонально без зниження органолептичних показників у рецептурі посічених напівфабрикатів замінювати до 3 % м'яса індиків на масу з грибів печериць.

Ключові слова: м'ясо індички, гриби, печериця, котлети, напівфабрикати, технологічні властивості.

Разработка рецептуры мясо-растительных рубленых полуфабрикатов на основе мяса индейки и грибов шампиньонов

Азарова Н. Г., Шлапак Н. В., Гарбажий К. С.

Целью работы была разработка рецептуры мясо-растительных измельченных полуфабрикатов нового поколения на основе мяса индейки и грибов шампиньонов и исследованиє их качества. Были приготовлены и изучены образцы мяса индейки с добавлением грибной массы шампиньонов. В ходе исследований были использованы физико-химические методы, включающие определение массовой доли влаги, влагоудерживающей способности, потери массы при термообработке, определение максимального напряжения сдвига и содержания хлорида натрия, а также органолептический анализ на основе определения вкуса, запаха, консистенции и вида на срезе для определения качества новых полуфабрикатов из мяса индейки и шампиньонов. Исследования показали, что добавление грибной массе в модельные фарши из мяса индеек приводит к увеличению массовой доли влаги в образцах, так как в грибной массе влаги больше, чем в мясе индейки. Водоудерживающая способность в модельных образцах снижается, что связано с увеличением влаги в образцах при добавлении грибной массы шампиньонов. Снижение водосвязующей способности способствует увеличению потерь массы фарша при термообработке. Было определено, что консистенция модельных образцов при добавлении грибной массы шампиньонов размягчается. При этом pH фарша опытных образцов почти не изменился. По данным анализа добавление грибной массы приводит к разрушению мясных фаршевых систем и снижению их функционально-технологических свойств. По результатам исследований был сделан вывод, что наиболее рационально без снижения органолептических показателей в рецептуре измельченных полуфабрикатов заменять до 3 % мяса индейки на массу из грибов шампиньонов.

Ключевые слова: мясо индейки, грибы, шампиньон, котлеты, полуфабрикаты, функциональные и технологические свойства.

ORCID iD:
Azarova N. https://orcid.org/0000-0003-2659-4620
Shlapak N. https://orcid.org/0000-0003-3382-3743
Harbazhiy K. https://orcid.org/0000-0001-8696-8810