

Plant components in the technology of meat products production

G. Shlapak,

кандидат технічних наук, доцент, Researcher ID: P-6853-2015

L. Agunova,

кандидат технічних наук, доцент, ORCID ID: 0000-0002-6708-7396

N. Azarova,

кандидат технічних наук, доцент, ORCID ID: 0000-0003-1750-6828

Одеська національна академія харчових технологій

Abstract. Meat and meat products are a necessary source of a significant list of biologically active substances with high bioavailability, they are enriched with essential amino acids, vitamins, macro- and microelements. That is why the invention of new types of meat-based food products and the improvement of existing technologies for their production is an important task for scientists and specialists in the meat processing industry. A necessary direction in the production of new types of meat products is the synthesis of raw materials of animal and plant origin. Such a technological mechanism makes it possible to obtain food products that are enriched with organic nutrients that positively affect the functioning of the organs and systems of the human body and contribute to the rational use of raw materials of animal origin, which makes it possible to expand the range of products. Scientists and researchers of this field studied the possibility of adding various plant components to the composition of meat products and found their positive influence on structural-mechanical, organoleptic, functional-technological properties and biological value. Thus, the purpose of the study is to substantiate the use of a plant component, namely couscous groats from durum wheat varieties in the production technology of meat semi-finished products. The article substantiates and experimentally proves the possibility of using couscous groats in the production technology of chopped semi-finished products. According to the results of the study of functional-technological and organoleptic indicators of model minced meat, it was established that it is rational to add no more than 9% of prepared couscous to the recipe of meatballs made of beef and pork. According to the quality indicators, the semi-finished products meet the requirements of the current regulatory documentation

Keywords: couscous, chopped semi-finished products, meatballs, functional and technological indicators, organoleptic assessment

INTRODUCTION

Meat and meat products are an important source of a significant list of biologically active substances with high bioavailability - these are essential amino acids, vitamins, macro- and microelements, etc. Therefore, the development of new types of meat-based food products and the improvement of already existing technologies for their production is an urgent task for scientists and specialists in the meat processing industry.

A promising direction in the production of new types of meat products is the combination of raw materials of animal and plant origin. This technological method allows you to obtain food products enriched

with natural nutrients that have a positive effect on the functioning of organs and systems of the human body and contribute to the rational use of raw materials of animal origin, which allows you to expand the range of products. Scientists have investigated the possibility of introducing various plant components into the composition of meat products and proved their positive effect on structural-mechanical, organoleptic, functional-technological properties and biological value [1-6]. Due to the biological features of growing farm animals, the chemical composition of meat raw materials can vary under the influence of

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many factors. Recently, the most pronounced impact on these processes has been observed due to the introduction of intensive technologies of fattening and keeping animals, which affects the mass fraction of fats and proteins in meat, as well as the values of functional-technological and organoleptic indicators. This, in turn, leads to a change in the quality characteristics of finished meat products, a decrease in the content of essential substances and nutritional values [7]. Therefore, another direction that can be solved by combining plant and animal raw materials is the possibility of balancing the chemical composition of the products according to the content of essential ingredients.

Specialists note a steady growth in the demand for meat semi-finished products. Urbanization of the population, the desire to save time for cooking, and an increase in the share of working women have a significant impact on this process. In addition, the features of industrial freezing contribute to the preservation of useful nutrients and guarantee the high safety of finished products. Thus, the demand for frozen meat semi-finished products, despite the crisis phenomena, will grow and will require the expansion of the range due to the use of ingredients that diversify the organoleptic indicators [8].

The most expedient when developing new recipes for meat products is the use of components that have a low cost and meet the national stereotypes of the Ukrainian consumer's diet. Authentic Ukrainian cuisine is known for the combination of meat or lard with a variety of cereals: buckwheat, buckwheat, groats. Recently, new products have appeared in the diet of Ukrainians that do not require complex cooking before consumption, have a low cost and have good taste properties. One such ingredient is couscous. According to the authors [9], the nutritional content of couscous is very similar to buckwheat, it has a high content of B vitamins and minerals; the energy value of 100 g of dry groats is 376 kcal, the mass fraction of proteins is 12.76%, fats are only 0.64%, carbohydrates are 77.43%, including fiber 5%. The glycemic index of couscous is 69 [9-11].

However, it should be noted that in the world there are several technological approaches to the production of couscous and its ingredient composition, but the most biologically valuable is couscous grain from durum wheat varieties (*Triticum durum*) [12].

The culture of couscous consumption has long existed in the world and, thanks to globalization, this cereal has spread from the African continent to Europe. The world production capacity of couscous is about 430 thousand tons per year [11]. Currently, in Europe, the most couscous is consumed in Italy and France, whose population has a balanced approach to choosing food products and combining them, which is confirmed by the classification of the Mediterranean diet (Italy) and the Gastronomic Art (France) into the intangible heritage of UNESCO in 2010 [13-14].

In Ukraine, the consumption of couscous is increasing every year, which is explained by its culinary features and the possibility of combining this cereal as a side dish with mushrooms, greens, stewed vegetables and meat. Couscous is currently not used in the industrial production of food products in our country.

The purpose of the study is to substantiate the use of couscous from durum wheat (*Triticum durum*) in the technology of semi-finished meat production. To achieve the goal, the following tasks were set:

- to investigate the influence of adding couscous on the change of functional and technological indicators of meat systems based on beef and pork;
- based on the change in the dynamics of organoleptic indicators, to investigate the permissible range of partial replacement of meat raw materials with pre-prepared couscous cereal in the production of chopped semi-finished products;
- evaluate the quality indicators of finished semi-finished products in accordance with the requirements of regulatory documentation.

MATERIALS AND METHODS

For conducting experimental studies, grade 1 beef meat with a content of visible connective and fatty tissues of no more than 6% was used, according to DSTU 6030:2008; semi-fatty pork meat with a fatty tissue content of 30..50% according to DSTU 7158:2010; couscous groats, according to TU U 15.6-30150670-001:2005; fresh onion, according to DSTU 3234-95; ground black pepper, according to DSTU ISO 959-1:2008; table salt, according to DSTU 3583:2015; drinking water, according to DSTU 7525:2014.

The mass fraction of moisture was determined according to DSTU ISO 1442:2005, pH – DSTU ISO 2917:2001, mass fraction of fat – DSTU 8380:2015, mass fraction of table salt – DSTU ISO 1841-2:2004,

The pressing method (the method of Grau and Hamm in the modification of V.L. Volovynska) was used to determine the moisture-binding capacity (MBC). The test sample of the product was thoroughly crushed and mixed. After that, a weight weighing 0.3 g (to the nearest 0.01 g) was taken and transferred to an ashless filter located on a glass plate. The top was covered with the same plate and a 1 kg weight was placed on it for 10 minutes. After that, the filter was released with a ruler, and then the outline of the spot around the pressed meat and adsorbed moisture was drawn with a pencil. The area of the formed spots was measured with a planimeter.

The mass fraction of tightly bound moisture in the sample was calculated using the formula:

$$X_1^1 = \frac{(A - (8,4F)) 100}{m} \cdot 100\%, \quad (1)$$

where X_1 is the mass fraction of bound moisture in the sample, % to the mass of meat; 8.4 – amount of

moisture absorbed by 1 cm² of ashless filter, mg; F – wet spot area, cm²; A – total moisture content in this sample, mg; m – weight of the sample, mg; 100 is a multiplier for conversion in %.

$$A = m\varphi, \quad (2)$$

where φ – moisture content in the sample in fractions of a unit.

Ultimate shear stress (USS) was determined using an automatic PMDP penetrometer. The minced meat sample was placed in a mold and the surface was leveled with a spatula. The device was connected to the electrical network, a form with a prepared sample of the product was placed on the object table of the device.

Pressed the “Network” button, then the “60s” button and the “Start” button. When fixing the penetration value on the digital scoreboard, remove the penetration value from the scoreboard and wait for the cone to return to its initial position. Based on the found value of the immersion depth, the ultimate shear stress was calculated according to the formula of P.A. Rebinder for plastic-viscous bodies:

$$\Theta = \frac{k_{\alpha}F}{h^2},$$

where Θ – the ultimate shear stress, Pa; k_{α} – a cone constant that depends on the angle at its apex; h – the immersion depth of the cone, m

$$F = mg, \quad (4)$$

m – mass of the cone with a rod and an additional load, kg; g – acceleration of free fall, m/s.

Heat treatment losses were determined by the gravimetric method, weighing product samples before and after heat treatment. Cooked samples were weighed after cooling to a temperature below 40°C.

The formula was used to calculate losses during heat treatment

$$TO = \left(\frac{M_1 - M_2}{M_1} \right) \cdot 100, \quad (5)$$

where TO – losses during heat treatment, %; M_1 – mass of raw material or semi-finished product prepared for heat treatment, kg; M_2 – mass of raw material or semi-finished product, after heat treatment, kg; 100 is a multiplier for conversion in %.

The stability of minced meat emulsion was determined using the method developed by R.M. Salavatulina, S.A. Aliyev, and V.M. Lyubchenko. Minced meat samples weighing 180...200 g were placed in hermetically sealed cans No. 3, weighed and cooked in a water bath at a temperature of 78...80°C for 1 hour, then cooled to a temperature of 12...15°C. After that, the cans were opened, the broth, together with the sepa-

rated fat, was transferred into pre-weighed aluminum containers. And the remaining cooked minced meat was dried with filter paper and weighed.

The stability of minced meat emulsion (SMM, % by mass of minced meat) was calculated according to the formula

$$SMM = \frac{m_c}{m} \cdot 100 \quad (6)$$

where m_c – mass of cooked minced meat after heat treatment and drying, g; m – the weight of minced meat before heat treatment, g; 100 – a multiplier for conversion in %.

To determine organoleptic indicators, a 9-point scale according to DSTU 4823.2:2007 and [15] was used.

RESULTS AND DISCUSSION

The object of research is the production technology of chopped semi-finished products (meatballs).

According to DSTU 4437:2005, meatballs are a frozen semi-finished product made of minced meat with the addition of other components (according to the recipe) in a spherical shape weighing 7...9 g. The components of the recipe can be vegetable components (onions, cereals, legumes, etc.) . According to the requirements, meat semi-finished products must contain at least 50% of meat raw materials, and meat products – at least 40%. These requirements were taken into account when conducting research and developing the recipe for meatballs with couscous.

At the initial stage, a study of the influence of couscous introduction on the dynamics of changes in functional and technological indicators (FTI) and structural and mechanical properties of systems based on meat raw materials was carried out.

For this purpose, a series of model mincemeats was prepared with the addition of pre-prepared couscous groats, because it is impossible to obtain the desired structure of mincemeat that will form well, keep its shape and have good organoleptic indicators when dry groats are introduced. Therefore, dry couscous groats were previously poured with hot water at a temperature of 80...90°C so that the water level was 1 cm above the groats. After that, they were brought to a boil and left to swell and cool. Cooled groats were used to prepare model minced meat.

Pork and beef (separately) were chopped on a small grater with a diameter of 3 mm. Next, in a mixer for preparing a series of model mincemeats, each type of meat was mixed with cereals for 8 minutes. The mass share of prepared groats in model minced meat was up to 18% with a step of 3%. Raw meat without additives was used as a control sample.

The results of the study of the dynamics of changes in the mass fraction of moisture W , (%), MBC (%) and USS (Pa) of model minced pork and beef are shown in fig. 1-3.

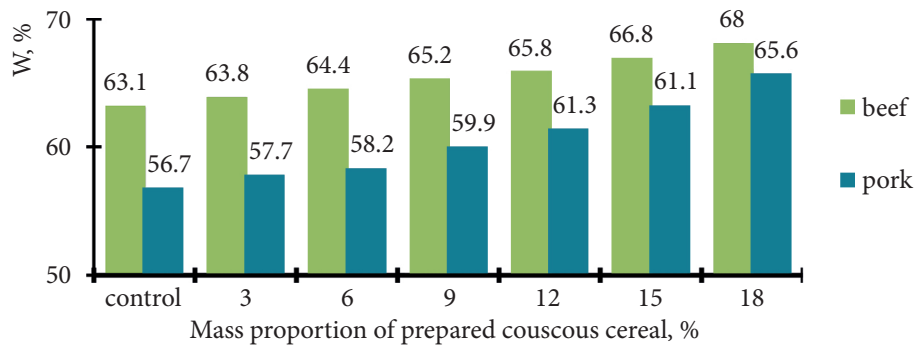


Figure 1. The influence of the introduction of prepared couscous cereal on the change in the mass fraction of moisture in model minced meat samples

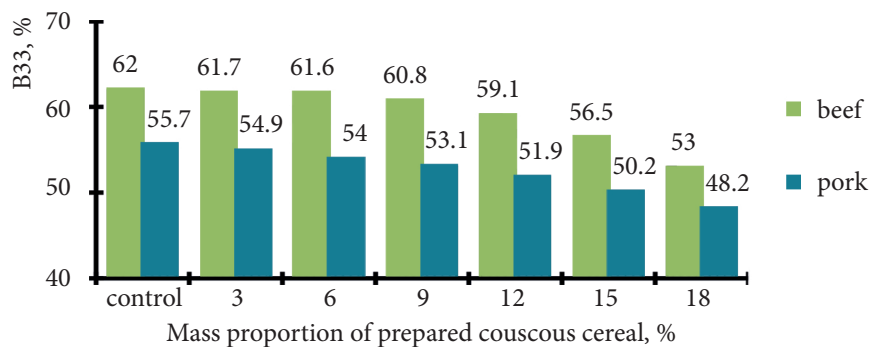


Figure 2 The influence of the introduction of prepared couscous cereal on the change of MBC in model minced meat samples

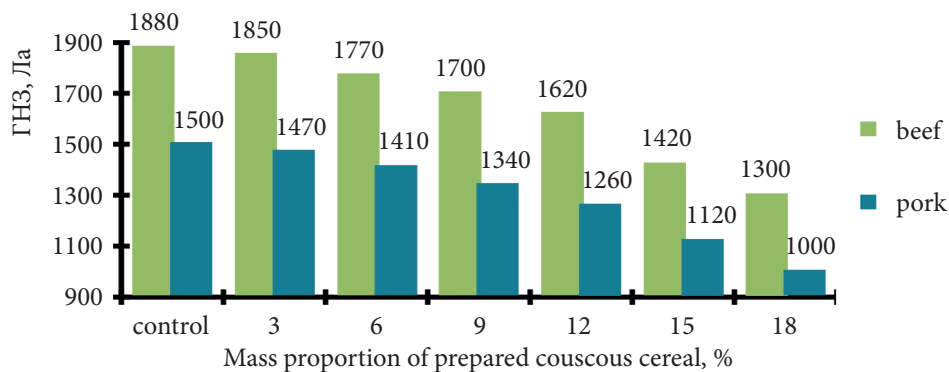


Figure 3 The influence of the introduction of prepared couscous cereal on the change of USS in model minced meat samples

The experimentally obtained data show that the addition of prepared couscous grain leads to an increase in the mass fraction of moisture in the system by 4.9...8.9% with an increase in the grain content, while the MBC indicator decreases by 7.5...9%. These changes are not critical, but may affect the provision of stable quality of finished products when using beef and pork meat. After all, the decrease in the MBC indicator occurs due to a decrease in the protein content of muscle tissue, so the system's ability to retain free moisture also decreases. Instead, an increase in the mass fraction of moisture occurs due to the

introduction of a significant fraction of moisture with the prepared couscous cereal. The data are correlated with the values obtained in the USS study. These indicators can affect the tenderness and juiciness of finished products, as well as cause an increase in losses during heat treatment.

Chopped semi-finished products are traditionally sold in a frozen form with a temperature in the center of the product no higher than -10°C , so another important indicator that must be taken into account when using new recipe components is determining their effect on the change in the value of active

acidity – pH. After all, significant fluctuations in the values of this indicator can affect the structure of native proteins of meat raw materials, changing their solubil-

ity and hydrophobicity. The influence of the addition of couscous on the pH of the model minced meat is shown in Fig. 4.

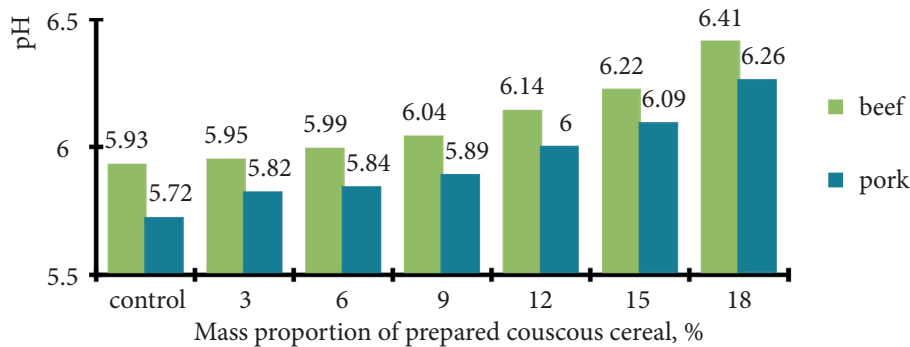


Figure 4 The influence of adding prepared couscous cereal on the pH change of the model minced meat samples

The obtained results demonstrate an increase in the pH value by 0.48...0.54 units with an increase in the proportion of the additive in the system. Such dynamics can be evaluated as positive, because it indicates the accumulation of soluble myofibrillar proteins in the system, which contribute to the strengthening of the minced meat structure during heat treatment.

To determine the possible value of losses during heat treatment, all model minced meats were subjected to heat treatment. Namely, round-shaped products weighing 7...9 g were formed and steamed to reach a temperature in the center of $72 \pm 2^\circ\text{C}$. The products were weighed before and after cooking. The results of the study of losses during heat treatment (HT, %) are shown in fig. 5.

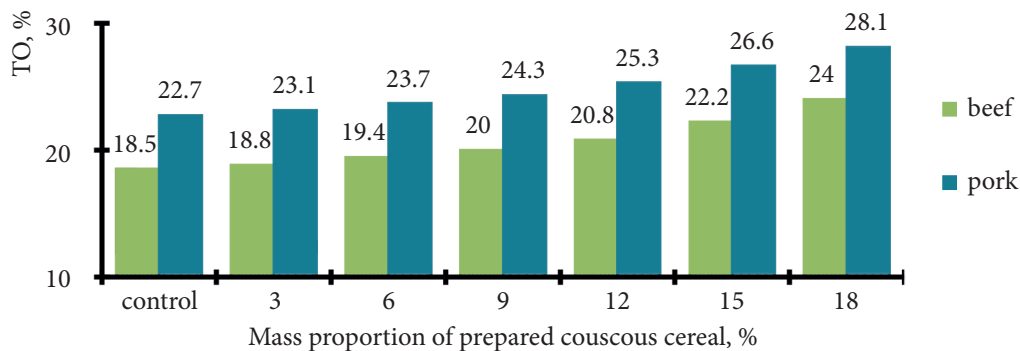


Figure 5 The influence of adding prepared couscous cereal on losses during heat treatment of model minced meat samples

The obtained data (Fig. 5) demonstrate that the model mincemeats with the introduction of prepared couscous grits lose 0.3...5.4% more during heat treatment, compared to the control samples. More significant indicators of losses during heat treatment were established in samples with a mass fraction of couscous of 12...18%, the dynamics of losses is higher in minced meat based on pork.

Thus, after examining the functional and technological indicators of model minced meat with the introduction of prepared couscous groats, it can be stated that it is rational to add up to 12% of prepared couscous groats to the composition of new types of meatballs, because a higher content of vegetable raw materials leads to a decrease in MBC, USS indicators, contributes to an increase content of unbound mois-

ture and reduces yield. The basis of the recipe should be beef meat, because fattier pork meat with such a combination has a significant effect on the change in FTI, and, accordingly, on the quality indicators of the finished product. Paying attention to the color, the presence of deformations and tears. When evaluating the species on the section, attention was paid to the uniformity of the distribution of components, according to the formulation, the color from dark to light pink. The smell in the raw form should be characteristic of good-quality raw materials and spices, in the cooked form, the taste and smell should be characteristic of the given product, without extraneous aftertaste and smell. The consistency of culinary processed semi-finished products is juicy, tender, not fragile. The results of the study are presented in the form of a profile in fig. 6.

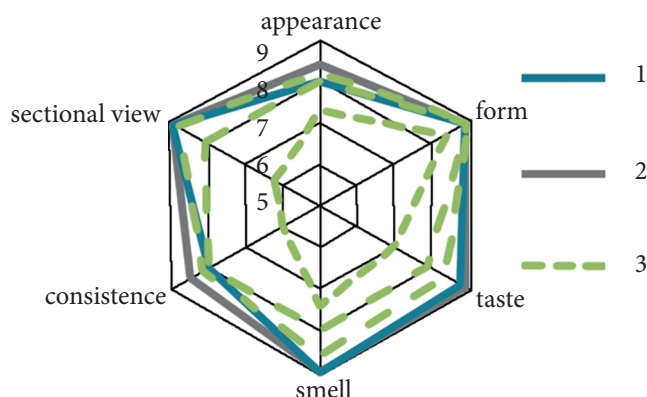


Figure 6 Profilogram of organoleptic evaluation of control and test meatball samples

The received sensory evaluation data show that, in general, all samples meet the requirements of the regulatory documentation in all indicators and do not differ significantly. However, the smallest area in the sensory evaluation is occupied by the profile of the fifth sample, which is characterized by a less pronounced taste and aroma, has a soft consistency, and when evaluating the appearance on the section, the tasters noted the presence of significant visible inclusions of

couscous, which was the reason for the reduced organoleptic evaluation of this sample. Thus, taking into account the results of the tasting evaluation, it is recommended to add no more than 9% of prepared couscous to the meatballs. Another important indicator that determines the quality of chopped semi-finished products is the stability indicator of minced meat emulsion, which characterizes the mass fraction of bound moisture and fat. The results are presented in fig. 7.

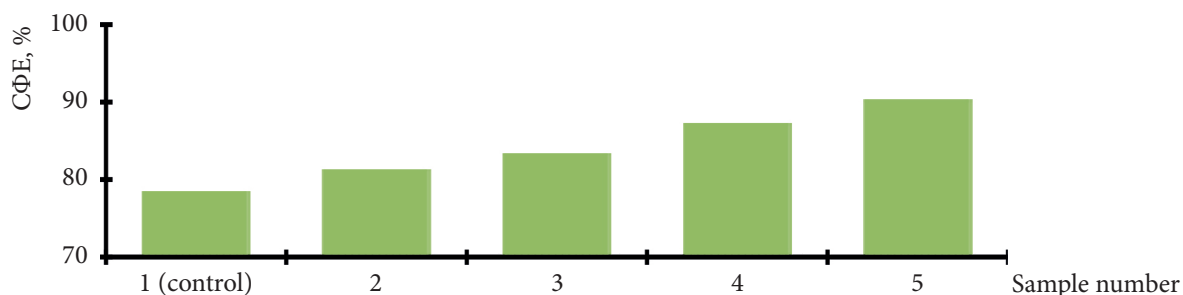


Figure 7. The value of the stability index of minced emulsion of control and experimental samples of chopped semi-finished products

At the next stage of the research, the organoleptic parameters of the samples of meatballs with the addition of prepared couscous cereal were determined. After all, it is the organoleptic properties of food products, including meat products, that directly affect the choice of the product by the consumer and objectively

All test samples show higher SMM values, compared to the control, which can be explained by the fact that the control sample contains more fat, which is less well connected to other components of the minced meat and is therefore easier to separate during heat treatment. In the test samples, the SMM value increases by 2.8...11.9%, compared to the control, which indicates a better binding of moisture and fat in the experimental samples and characterizes their consistency as denser. This can be explained by the fact that couscous contains gluten, which has high elasticity and is able to retain a significant

amount of moisture when it is separated from meat proteins during heat treatment. This study also confirms the expediency of using couscous groats in the production technology of chopped semi-finished products. At the next stage, the organoleptic and physico-chemical parameters of meatballs containing 9% couscous groats and their compliance with the requirements of regulatory documentation were investigated. For this, two batches of meatballs were made according to the traditional recipe, according to DSTU 4437:2005 and according to the experimental recipe. Then they were divided into two parts: one part was frozen to a temperature in the center no higher than 10°C and these products were evaluated in the frozen state; the second - was boiled in boiling water for 15 minutes, removed from the water, cooled to a temperature of 40°C and organoleptic indicators were evaluated. Physico-chemical indicators

were evaluated in raw semi-finished products. The obtained results are presented in the table. 1. All test samples show higher SMM values, compared to the control, which can be explained by the fact that the control sample contains more fat, which is less well connected to other components of the minced meat and is therefore easier to separate during the heat treatment process. In the experimental samples, the value of the SMM indicator increases by 2.8...11.9%, compared to the control, which indicates a better binding of moisture and fat in the experimental samples and characterizes their consistency as denser. This can be explained by the fact that couscous contains gluten, which has high elasticity and is able to retain a significant amount of moisture when it is separated from meat proteins during heat treatment. This study also confirms the expediency of

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Table 1. Quality indicators of meatballs with couscous grains

Name of the indicator	Control sample (according to DSTU 4437:2005)	Test sample
Organoleptic indicators		
Appearance	Not stuck together, not deformed. The shape of one piece is spherical. When shaking the packaging unit, they make a clear, distinct sound.	
Sectional view	The minced meat is evenly mixed, from dark red to light pink in color.	
Consistence	In boiled form - juicy, tender, not fragile.	
Taste and smell	In raw form, they are characteristic of good-quality raw materials and spices. In boiled - characteristic of this product. Without extraneous taste, smell.	
Physico-chemical parameters		
Mass fraction of moisture in minced meat, %, not more than	66.92	68.35
Mass fraction of fat, %, not more than	10.92	8.14
Mass fraction of table salt, %	1.82	1.67
Mass of one piece, g	8±1	8±1

The results of the conducted research demonstrate that the partial replacement of grade I beef with prepared couscous grits and raw fat with semi-fat pork will allow to obtain products with stable functional and technological properties and good taste characteristics. The quality indicators of such products meet the requirements of regulatory documentation. This product will make it possible to rationally use raw materials of animal origin and reduce the cost of production.

CONCLUSIONS

Theoretical and experimental research made it possible to generalize the following:

1. Couscous grits are a promising ingredient for use in the recipes of chopped semi-finished products.
2. It was experimentally established that the introduction of prepared couscous cereal up to 12% has an

insignificant effect on the change of functional-technological and structural-mechanical indicators, and an increase in the mass fraction of the plant component up to 18% is inappropriate due to a drop in MBC, USS and an increase in losses during heat treatment.

3. Organoleptic evaluation of the line of experimental samples made it possible to establish that it is advisable to use no more than 9% of couscous grains in new types of chopped semi-finished products.

4. In the experimental samples, organoleptic and physico-chemical quality indicators are determined, which fully meet the requirements of DSTU.

It is advisable to direct further research to the establishment of product storage parameters, the assessment of the economic effect and the development of regulatory documentation for the introduction of the technology into industrial production.

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Рослинні компоненти у технології виробництва м'ясопродуктів

Г. В. Шлапак,

кандидат технічних наук, доцент, Researcher ID: P-6853-2015

Л. В. Агунова,

кандидат технічних наук, доцент, ORCID ID: 0000-0002-6708-7396

Н. Г. Азарова,

кандидат технічних наук, доцент, ORCID ID: 0000-0003-1750-6828

Одеська національна академія харчових технологій

Анотація. М'ясо та м'ясні продукти є необхідним джерелом вагомого переліку біологічно активних речовин з високою біологічною доступністю, вони збагачені незамінними амінокислотами, вітамінами, макро- і мікроелементами. Саме тому винайдення нових видів харчових продуктів на м'ясній базі і покращення вже наявних технологій їх виробництва є вагомим завданням для науковців і спеціалістів м'ясопереробної галузі. Необхідним напрямком при виробництві нових видів м'ясопродуктів є синтез сировини тваринного і рослинного походження. Такий технологічний механізм дозволяє одержувати харчові продукти, які є збагаченими органічними нутрієнтами, що позитивно впливають на функціонування органів і систем людського організму та сприяють раціональному застосуванню сировини тваринного походження, що дає змогу розширити асортимент продукції. Вченими та дослідниками цієї сфери було вивчено можливість внесення до складу м'ясопродуктів різноманітних рослинних компонентів і виявлено їх позитивний вплив на структурно-механічні, органолептичні, функціонально-технологічні властивості та біологічну цінність. Таким чином, метою дослідження є обґрунтування використання рослинного компоненту, а саме крупи кускус із твердих сортів пшениці в технології виробництва м'ясних напівфабрикатів. У статті обґрунтовано і експериментально доведено можливість використання крупи кускус в технології виробництва посічених напівфабрикатів. За результатами дослідження функціонально-технологічних і органолептичних показників модельних фаршів встановлено, що до рецептури фрикадельок із яловичини і свинини раціонально вносити не більше 9 % підготовленої крупи кускусу. За показниками якості напівфабрикати відповідають вимогам діючої нормативної документації

Ключові слова: кускус, посічені напівфабрикати, фрикадельки, функціонально-технологічні показники, органолептична оцінка