қорғасын тұздарымен улану кезіндегі болатын өзгерістерді біршама қалпына келтіретіндігі байқалды. Сорбент өз кезегінде уланудан кейін болған организмде болған өзгерістерді біршама бастапқы қалпына келтіретіндігі анықталды.

ӘДЕБИЕТТЕР ТІЗІМІ

1. Республикасында агроөнеркәсіптік кешенді дамыту жөніндегі 2013–2020 Қазақстан жылдарға арналған «Агробизнес — 2020» бағдарламасын бекіту туралы Қазақстан Республикасы Үкіметінің 2013 жылғы 18 ақпандағы № 151 қаулысы. - [Электрондық ресурс]. Қолжетімділік тәртібі: http://adilet.zan.kz/kaz/docs/P1300000151. (өтініш берген күн 15.04.2019).

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RESEARCH OF STRUCTURAL AND MECHANICAL PROPERTIES OF NATIONAL RESTRUCTURED MEAT PRODUCTS

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The article presents the results of a study of the structural and mechanical properties, the dependence of the objective function and humidity of lamb and horse meat on the duration of the mechanical treatment. Changes in water activity and humidity of raw meat, depending on the duration of the mechanical treatment. It has been established that the use of multicomponent brine helps to increase water binding capacity (WBC) and improves the structural and mechanical properties of lamb and horse meat products. Studies have shown that increasing the WBC of meat occurs within 5 days of exposure, and the use of mechanical treatment helps to increase WBC in the first 24 hours.

Key words: lamb, horsemeat, structural and mechanical properties, multicomponent brine, machining.

ИССЛЕДОВАНИЕ СТРУКТУРНО-МЕХАНИЧЕСКИХ СВОЙСТВ НАЦИОНАЛЬНЫХ РЕСТРУКТУРИРОВАННЫХ МЯСНЫХ ПРОДУКТОВ

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В статье приведены результаты исследования структурно-механических свойств, зависимость целевой функции и влажности баранины и конины от продолжительности механической обработки, а также исследованы изменения активности воды и влажности мясного сырья в зависимости от продолжительности механической обработки. Установлено, что использование многокомпонентного рассола способствует повышению влагосвязывающей способности (ВСС) и улучшению структурно-механических свойств продуктов из баранины и конины. Исследованиями установлено, что повышение ВСС мяса идет в течение 5 суток выдержки, а использование механической обработки способствует увеличению ВСС в первые 24 ч.

Ключевые слова: баранина, конина, структурно-механические свойства, многокомпонентный рассол, механическая обработка.

ҰЛТТЫҚ ҚАЙТА ҚҰРЫЛЫМДАЛҒАН ЕТ ӨНІМДЕРІНІҢ ҚҰРЫЛЫМДЫҚ-МЕХАНИКАЛЫҚ ҚАСИЕТТЕРІН ЗЕРТТЕУ

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Мақалада құрылымдық-механикалық қасиеттерін зерттеу нәтижелері, қой еті мен жылқы етінің мақсатты функциясы мен ылғалдылығының механикалық өңдеу ұзақтығына тәуелділігі келтірілген сонымен қатар механикалық өңдеу ұзақтығына байланысты су белсенділігінің және ет шикізатының ылғалдылығының өзгеруі зерттелген. Көп құрамдас тұздықты пайдалану ылғал байланыстыру қабілеті (ЫБҚ) жоғарылауына және қой еті және жылқы етінен жасалған өнімдердің құрылымдық-механикалық қасиеттерін жақсартуға ықпал ететіні анықталды. Зерттеу барысында еттің ЫБҚ жоғарылауы 5 тәулік бойы сақталады, ал механикалық өңдеуді пайдалану алғашқы 24 сағатта ЫБҚ ұлғаюына ықпал етеді.

Негізгі сөздер: қой еті, жылқы еті, құрылымдық-механикалық қасиеттер, көп құрамдас тұздық, механикалық өңдеу.

Introduction

Meat and meat products are one of the most important components in human nutrition. This is mainly a source of high-quality protein and vitamins necessary for the proper development of the organism. Meat humidity varies from 41% to 78%. With pressure on the muscle tissue, moisture protrudes from it. The moisture content in a muscle, free from fat, ranges between 72 and 78%. With age, the water content in the muscle tissue of animals is reduced [1].

The quality of meat depends on the activity of water. To assess meat, the absolute value of humidity is not enough, since water is in different conditions in animal tissues. Water activity affects the stability of meat and meat products during

storage, and is defined as the ratio of the pressure of water vapour over the product to the pressure of saturated steam of distilled water. One of the ways to reduce the activity of water in meat products (not dried) is to add technological additives to the recipe such as salt, sugar, vegetable dietary fiber, protein preparations, phosphate complexes and others, and it should be borne in mind that micromolecules will be most active food additives (for example: table salt, polyphosphates, etc.) than macromolecules (protein preparations, fats, etc.) [2].

Materials and methods of research

- hip leg of lamb of 1 category of fatness and zhaya;
- Goji berry extract;
- buckwheat flour;
- salt;
- sodium nitrite;
- phosphates;
- water.

Consider the analysis of physico-chemical and structural-mechanical characteristics on the example of a national restructured meat product from lamb and horse meat using a multi-component brine.

To enrich the product with lamb and horse meat with nutritious ingredients during salting, we used Goji berry extract and buckwheat flour.

The meat was syringed in an amount of 5 to 20 mass. % and processed in the tender (brand - ЭТДУ, Model ТУЗ-KZ). The duration of the mechanical treatment and the content of the injection brine were optimized by changing the limit shear stress (LSS), plasticity (Pl) and humidity in raw meat.

The mathematical processing of the results is represented by a function in the form:

$$У = 0{,}024 \cdot X^4 - 0{,}3249 \cdot X^3 + 1{,}4457 \cdot X^2 - 2{,}7191 \cdot X + 3{,}1167$$

Results and discussion

The results were optimized in four stages. Based on the obtained Trend equations, the maxima and minima of the functions by the method of finding the first derivative are revealed, correspond to the optimal values of LSS, plasticity and humidity (Y_1, Y_2, Y_3) at a concentration of multicomponent brine (MCB) of 5 - 20%. For all cases, the maximum and minimum values of LSS, plasticity and humidity are within 18% of the content of multicomponent brine. (Fig. 1).

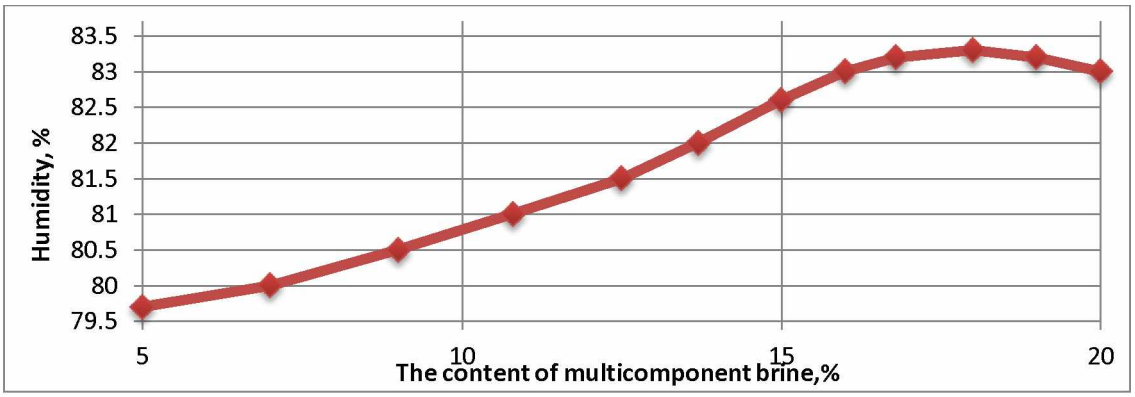


Figure 1 - The dependence of the humidity of raw meat from mechanical treatment

At the next stage, the dependence of Y_1, Y_2, Y_3 on the duration of mechanical treatment was established for 1-6 hours. At the fourth stage, on the basis of the proposed objective function, the dependence k = f (τ) was constructed, where, τ is the duration of mechanical treatment. (Fig. 2)

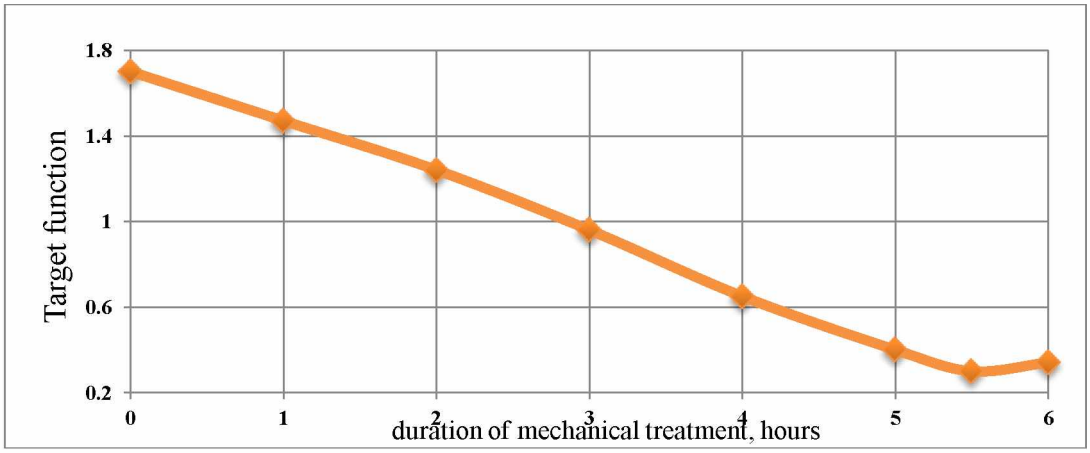


Figure 2 - Dependence of the objective function on the duration of mechanical treatment

An essential indicator of product quality is the tenderness of meat. The decrease in WBC of lamb and horse meat after mechanical treatment occurs as a result of a shift the pH of meat to acid, accelerating the development of rigidity of muscles. The degree of muscle contraction during post-mortem rigor mortis depends on the rate of decrease in pH, which in turn is a direct function of temperature. Changes in shear stress and plasticity, which are indicators of the consistency of meat, indicate their dependence on the duration of mechanical treatment

To control the optimal parameters for salting lamb and horsemeat MCB, were used water activity, heat of binding water and product humidity, which are most sensitive to various changes in technological factors in the production of national restructured meat products from lamb and horse meat.

The technology of restructured national meat products of lamb and horse meat using MCB based on the extract of Goji berry, buckwheat flour was developed. The amount of syringe brine is 5 - 20% by weight of the feedstock. As a control sample served raw meat from (horsemeat and lamb), salted with traditional brine.

Introduction to the composition of plant components - extract of Goji berry and buckwheat flour would ensure the production of national restructured meat products, with the specified structural and mechanical characteristics and shelf life of the finished products.

The injection of the proposed brine is characterized by a uniform saturation of the pieces of meat with a brine, minimal drainage of the brine after injection, and a uniform distribution of curing substances inside the pieces. The brine evenly fills the space between the fibers of the meat and carries the components to all areas inside the processed pieces. Thanks to this treatment, the meat becomes more elastic, juicy during heat treatment, has tendering properties, because the amount of brine held is up to 20 %.

Due to the action of salt, muscle tissue additionally swells, which helps to increase the yield of the finished product.

A change in the cellular structure promotes the introduction of curing substances, for example, dyes, meat quickly acquires the desired pink-red color. The composition of the composition for brine is shown in Figure 3.

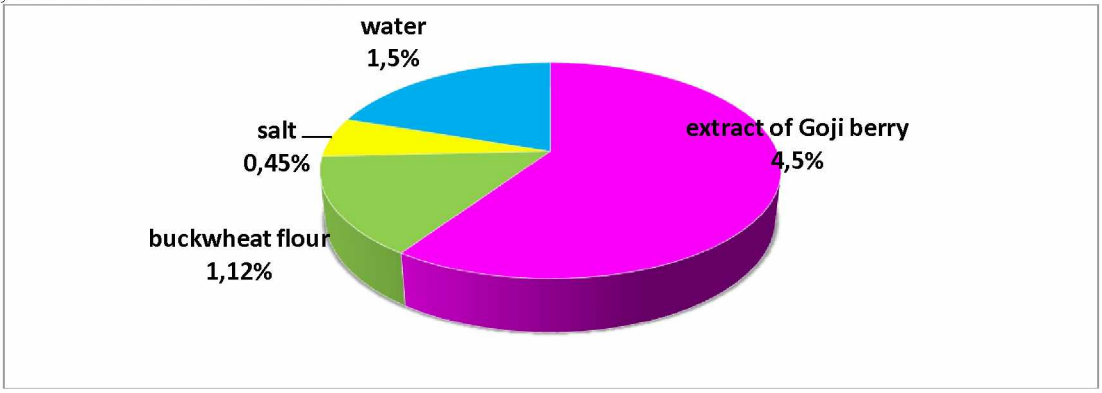


Figure 3 - Composition for multicomponent brine

With a meat moisture content of 73.6% and a duration of 6 hours of mechanical treatment, the water activity reaches 0.940. Further massage does not lead to a significant change in the magnitude of the activity of water. (Table 1)

Table 1 - Changes in water activity and humidity of salted meat raw materials depending on the duration of mechanical treatment

Duration of mechanical treatment, hours	Water activity, Aw		Humidity, W, %		Heat water binding, Δ r 103 J / kg	
	experience	control	experience	control	experience	control
0	0,988	0,965	87,3	75,4	0,5	0,5
1	0,976	0,960	82,7	73,8	0,9	0,7
2	0,968	0,956	78,1	72,6	1,6	1,3
3	0,960	0,951	76,0	72,1	1,9	1,4
4	0,954	0,947	74,9	71,8	2,3	1,9
5	0,947	0,943	74,2	71,1	2,5	2,0
6	0,940	0,938	73,6	70,4	2,6	2,3

As can be seen from table 2, with a duration of mechanical treatment of up to 6 hours, the humidity of lamb and horse meat with an MCB content of 20% reaches 85%.

Water in food products is a dispersion medium and determines their structure. The structural and mechanical properties of meat products are affected by both moisture content and the form of its connection with the product. Most products are subjected to mechanical, hygro- and hydrothermal processing and mass transfer processes in which of moisture content and change its state [3].

Table 2 - Dynamics of changes in LSS, plasticity and humidity of raw meat depending on the duration of mechanical treatment and the content of multicomponent brine

Duration of mechanical treatment, hours	Content of MCB, %	Dynamics of changes		
		LSS, 10^{-5}	Plasticity, 10^{2}	Humidity, %
1	5	2,07	4,61	78,2
	10	2,1	4,69	78,6
	15	2,08	4,65	79,2
	20	2,09	4,6	79,6
2	5	2,01	4,73	78,4
	10	2,00	4,77	78,8
	15	1,97	4,98	79,9
	20	1,95	4,87	80,2
3	5	1,94	4,78	78,5
	10	1,91	4,82	79,4
	15	1,92	5,11	80,7
	20	1,9	4,99	80,9
4	5	1,91	4,84	78,9
	10	1,88	4,9	79,9
	15	1,83	5,18	81,6
	20	1,82	5,14	81,1
5	5	1,87	4,89	79,6
	10	1,81	4,93	80,7
	15	1,77	5,24	82,3
	20	1,79	5,19	82,4
6	5	1,81	4,94	79,9
	10	1,78	4,99	81,4
	15	1,71	5,33	83,8
	20	1,69	5,27	85,0

The structural and structural-mechanical properties of meat and meat products are closely related to their thermodynamic properties (humidity, water activity, energy and form of water bind) [4,5]. Establishing the dependence of the structural and structural-mechanical characteristics of food products on their thermodynamic characteristics makes it possible to identify forms of communication in the product. The dependence of the structure and structural-mechanical characteristics of lamb and horse meat products on the thermodynamic properties was studied.

The shear stress was taken as a structural-mechanical parameter, and the activity of water (aw) was taken as a thermodynamic parameter.

Graphs of the dependence of the shear stress for boiled-smoked national meat products from lamb, as well as the activity of water on the humidity of meat products are given. The initial moisture content of meat products was 80-85%, A_w = 0.97-0.98. From the graph (Fig. 1), at high humidity values, the dependence of the cut voltage of meat raw materials on humidity varies according to rectilinear law with a slight slope to the abscissa axis.

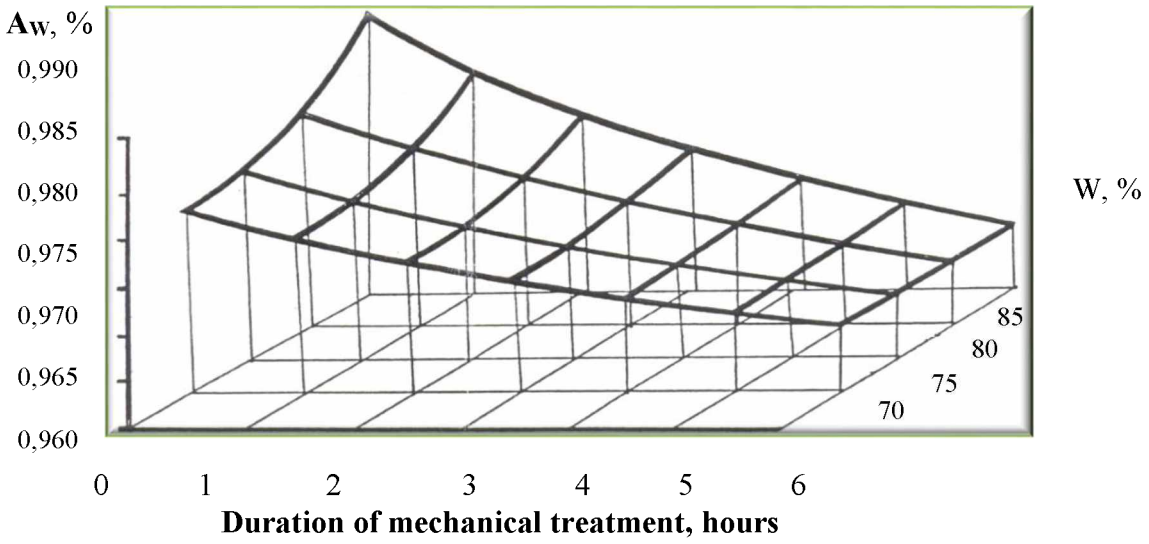
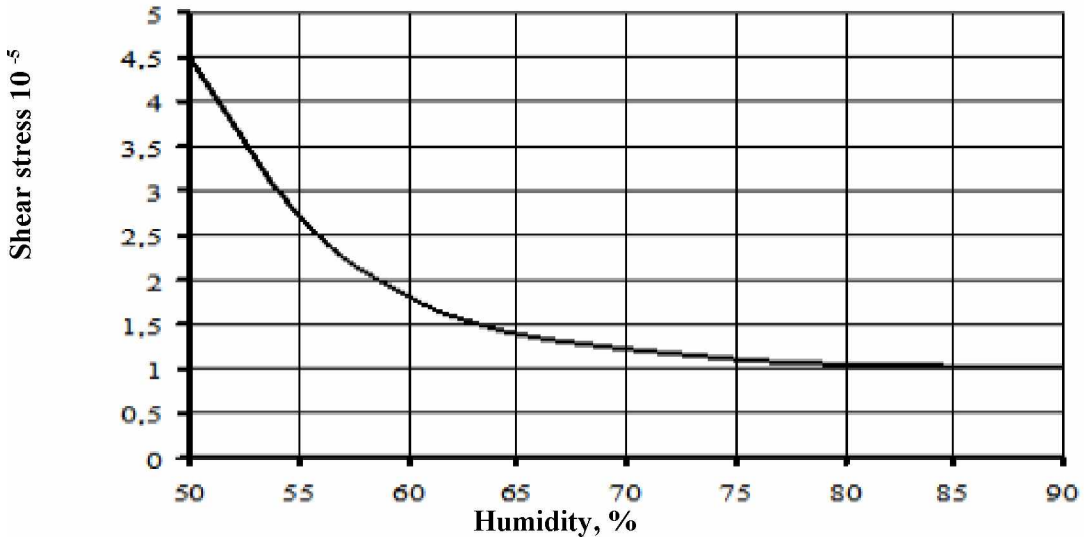
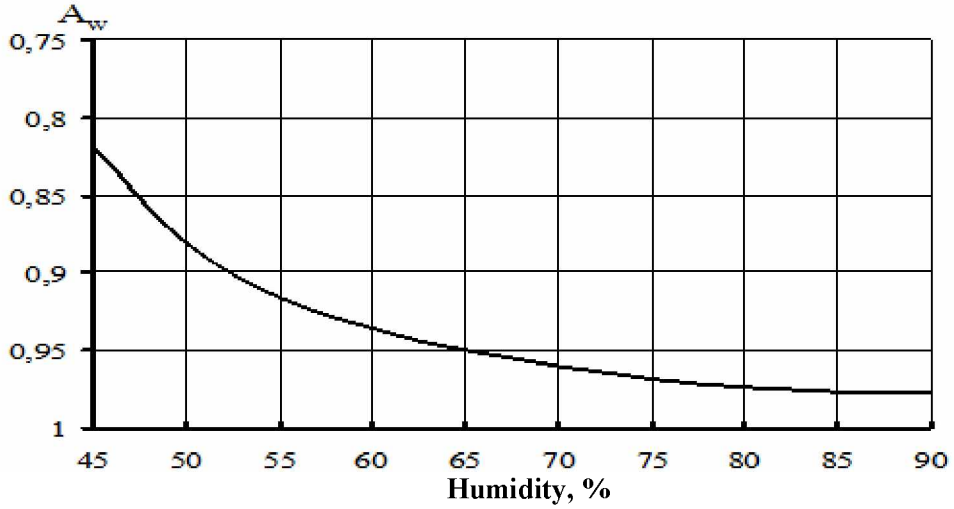


Figure 1- A graph of the dependence of the activity of water of salted meat raw materials on humidity and the duration of mechanical treatment



a) Graph of the dependence of the shear stress on the humidity of meat products from lamb and horse meat



b) Graph of the dependence of the water activity on the humidity of meat products from lamb and horse meat
Figure 2 - Graph of the dependence of the shear stress and water activity on the humidity of meat products from lamb and horse meat

Figure 2 shows a graph of the dependence of the shear stress and water activity on humidity of meat products from lamb and horse meat.

During this period, humidity in macro- and mesopores does not affect the shear stress. With a decrease in the humidity of cooked smoked lamb products below 60 % and A_w = 0.9, the shear stress begins to increase according to a curved law. This curved section continues to moisture content of 45-50% and A_w = 0.80-0.85. After that, the value of the shear stress increases according to a straightforward law, but with a greater slope to the abscissa axis than at the beginning, that is, when meat products have high humidity.

The nature of the change in water activity from the moisture content of lamb and horse meat products mainly corresponds to the nature of the change in shear stress.

Straight portion at the shear stress and water activity graph characterizes contents of macro- and mesocapillary humidity. Over a given humidity interval, the shear stress depends only on the structure of the meat.

The curved section on the graph of the cutoff voltage and water activity makes it possible to judge that this section characterizes the state of humidity in the micropores of meat products.

With a decrease in the humidity of meat products below 45% and A_w = 0.8-0.9, microcapillary humidity is removed, while the mobility of water molecules gradually decreases, which leads to a hardening of the structure of meat products. With a further decrease in humidity, the shear stress value increases sharply. This section corresponds to humidity at which intermolecular-structural humidity remains in the products, which has a significant effect on the magnitude of the voltage. With a gradual decrease in this humidity, the product shrinks due to the convergence of macromolecules, and their mobility is limited. During this period, the dependence of water activity on humidity also has a straight section. A decrease in humidity leads to a sharp decrease in the activity of water and, accordingly, an increase in the binding energy of water.

Thus, based on the data obtained, the dependence of the shear stress on the humidity content of lamb and horse meat products characterizes their structural and mechanical properties depending on the forms of water binding.

Conclusions

The experiments showed that the use of multicomponent brine and mechanical treatment improves WBC and improves the structural and mechanical properties of national restructured lamb and horse meat products. An increase in WBC of meat takes place within 5 days of exposure, and the use of mechanical treatment increases WBC in the first 24 hours. With further exposure, the values of WBC practically do not change (69,0-69,3%).

The use of MCB favorably affects the strength properties of meat products. Using mechanical treatment improves plasticity by 8–9%. The study of shear stress confirms the pattern of change in the plasticity of meat.

Also, the use of multicomponent brine favorably affects the strength properties of

national restructured meat products. The injection of the proposed brine is characterized by a uniform saturation of the pieces of meat with a brine, minimal drainage of the brine after injection, and a uniform distribution of curing substances inside the pieces. The brine evenly fills the space between the fibers of the meat and carries the components to all areas inside the processed pieces. According mechnical treatment, the meat becomes more elastic, juicy during heat treatment, has tendering properties.

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ПОВЫШЕНИЕ КАЧЕСТВА НАЦИОНАЛЬНОГО МЯСНОГО ПРОДУКТА НОВОГО ПОКОЛЕНИЯ

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Цель данного научного исследования состоит в том, чтобы установить потенциал улучшения окислительной стабильности и улучшения качества с помощью двух концентраций -0,5% и 1,0%, в качестве добавок экстракта ягоды годжи(LyciumBarbarum L.) и гречневой муки (Fagopýrum esculéntum) для изготовления национального реструктурированного варенокопченого мясного продукта из конины «Канагат» с улучшенным качеством и окислительной стабильностью. Применяемая технология позволяет производить новые национальные мясные продукты из конины, обогащенные экстрактом ягоды годжи (LyciumBarbarum L.) в количестве 9,82 ± 0,25 мг/г и гречневой мукой(Fagopýrum esculéntum) в количестве 9,73 ± 0,21 мг/г.

Ключевые слова: конина, национальный мясной продукт, гидролиз, антиоксиданты.

ЖАҢА ЗАМАНҒЫ ҰЛТТЫҚ ЕТ ӨНІМІНІҢ САПАСЫН АРТТЫРУ

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Бұл ғылыми зерттеудің мақсаты сапасы жақсартылған және тотығу тұрақылығы бар жылқы етінен «Қанағат» ұлттық қайта құрылымдалған пісіріліп ысталған ет өнімін жасау үшін қоспа ретінде годжи жидектері экстракты (Lycium Barbarum L.) және қарақұмық ұнының (Fagopýrum esculéntum) 0,5% және 1,0% екі концентрацияның көмегімен тотығу тұрақтылығын жақсарту және сапасын жақсарту потенциалын анықтау болып табылады. Қолданылатын технология годжи жидектері экстрактымен (Lycium Barbarum L.) 9,82 ± 0,25 мг/г мөлшерінде және қарақұмық ұнымен (Fagopýrum esculéntum) мөлшерінде 9,73 ± 0,21 мг/г байытылған жылқы етінен жаңа ұлттық ет өнімдерін өндіруге мүмкіндік береді.

Негізгі сөздер: жылқы еті, ұлттық ет өнімі, гидролиз, антиоксиданттар.