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DEVELOPMENT OF TECHNOLOGY AND STUDYING THE QUALITY OF COMBINED MEAT BREAD WITH THE ADDED POWDER FROM TOMATO POMACE

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Functional meat products can be productively created by mutually replacing some components of the formulation with raw materials of plant origin, including vegetables and their secondary products with biologically active valuable substances. The purpose of the work is to develop technology and study the quality characteristics of meat bread with the enrichment of powder from tomato production waste in various proportions, taking into account consumer interest in products with high nutritional and biological value. The creation of meat loaf with the addition of tomato powder was carried out according to traditional schemes for the production of boiled sausage products. After determining the optimal amount of the herbal additive in the amount of 15%, samples of meat bread were prepared and examined for basic quality indicators. Experimental studies of prototypes were carried out using standard research methods. Based on the results of studying the physicochemical characteristics of meat loaf with tomato pomace powder, it was noticed that the pH value, water activity (aw), and moisture content in meat loaf samples naturally decreased after adding 15% tomato powder. This improves the shelf life and safety of meat products because they are more resistant to spoilage microorganisms. Based on the results of experimental studies, it can be concluded that the developed composition of meat loaf recipes with high nutritional and biological value, thanks to the use of secondary raw materials in the form of tomato pomace powder, and the use of processes with minimal energy consumption, is economically feasible.

Keywords: functional products, raw meat, tomato pomace, powder, nutritional value, chemical composition, microbiological study.

ҚЫЗАНАҚ ҰНТАҒЫ ҚОСЫЛҒАН ҚҰРАМДАСТЫРЫЛҒАН ЕТ НАНЫНЫҢ ТЕХНОЛОГИЯСЫН ӘЗІРЛЕУ ЖӘНЕ САПАСЫН ЗЕРТТЕУ

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Функционалды ет өнімдерінің кейбір компоненттерін өсімдік тектес шикізатпен, соның ішінде көкөністер мен олардың екіншілік өнімдерінің биологиялық белсенді құнды заттарымен өзара алмастыруға болады. Зерттеу жұмысының мақсаты – тұтынушылардың тағамдық және биологиялық құндылығы жоғары өнімдерге қызығушылығын ескере отырып, әртүрлі пропорцияда қызанақ өндірісінің қалдығын, қызанақ ұнтағымен ет нанын байыту технологиясын әзірлеу және сапалық сипаттамаларын зерттеу. Қызанақ ұнтағы қосылған ет нанын жасау технологиясы, пісірілген шұжық өнімдерін өндірудің дәстүрлі схемалары бойынша жүзеге асырылды. Зерттеу нәтижесінде, өсімдік қоспаларының оңтайлы мөлшері 15% құрайтыны анықталғаннан кейін ет нанының үлгілері дайындалып, негізгі сапа көрсеткіштеріне сараптама жүргізілді. Тәжірибелік үлгілерді зерттеу стандартты әдістерді қолдану арқылы жүргізілді. Қызанақ ұнтағы қосылған ет нанының физика-химиялық көрсеткіштеріне сәйкес, 15% қызанақ ұнтағы қосылған ет наны үлгілерінің рН мәні, су белсенділігі (aw), ылғалдылығы төмендегені байқалды. Сонымен қатар, ет өнімдерінің сақтау мерзімі ұзарды және микроорганизмдерге төзімділігі артты, қауіпсіздігі жоғарылады. Зерттеулердің нәтижелеріне сүйенсек, қайталама екіншілік шикізатты қызанақ қалдығының ұнтағын қолданудың және ең аз энергия шығыны бар процестерді пайдаланудың арқасында құрамы тағамдық және биологиялық құндылығы жоғары ет нанының рецептурасы әзірленген және экономикалық тұрғыдан тиімді деген қорытынды жасауға болады.

Негізгі сөздер: функционалды тағамдар, ет шикізаты, қызанақ қалдығы, ұнтақ, химиялық құрамы, микробиологиялық зерттеу.

РАЗРАБОТКА ТЕХНОЛОГИИ И ИЗУЧЕНИЕ КАЧЕСТВА КОМБИНИРОВАННОГО МЯСНОГО ХЛЕБА С ДОБАВЛЕНИЕМ ПОРОШКА ИЗ ТОМАТНОГО ЖМЫХА

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Функциональные мясные продукты могут быть продуктивно созданы путем взаимной замены некоторых компонентов рецептуры сырьем растительного происхождения, в том числе овощами и их вторичными продуктами с биологически активными ценными веществами. Целью работы является разработка технологии и изучение качественных характеристик мясного хлеба с обогащением порошка из отходов томатного производства в различных соотношениях с учетом интереса потребителей к продуктам с высокой пищевой и биологической ценностью. Создание мясного хлеба с добавлением томатного порошка осуществлялось по традиционным схемам изготовления вареных колбасных продуктов. После определения оптимального количества растительной добавки в количестве 15% были приготовлены образцы мясного хлеба и исследованы на основные качественные показатели. Экспериментальные исследования опытных образцов проводились с применением стандартных методов исследования. По результатам изучения физико-химических характеристик мясного хлеба с порошком из томатных выжимок было замечено, что значение рН, активности воды (aw), содержания влаги в образцах мясного хлеба закономерно снижалось после добавления 15% томатного порошка. Это улучшает срок хранения и безопасность мясных продуктов, поскольку в этом случае они более устойчивы к микроорганизмам, вызывающим порчу. По результатам экспериментальных исследований можно сделать вывод, что разработанная композиция рецептов мясных хлебов с высокой пищевой и биологической ценностью, благодаря использованию вторичного сырья в виде порошка из томатного жмыха, и применению процессов с минимальными энергозатратами, является экономически целесообразной.

Ключевые слова: функциональные продукты, мясное сырье, томатный жмых, порошок, пищевая ценность, химический состав, микробиологическое исследование.

Introduction

Saturation of food markets of Kazakhstan with high-quality meat products of own production

is one of the most important socio-economic tasks for the near future [1]. The main part of harvested mutton and turkey is sold to the population in the

form of meat or used mainly for the production of second courses in the public catering system. An insignificant part of raw materials is used for sausage and canning production, which indicates the need to develop promising methods of processing mutton and turkey, preparing it for the manufacture of high-quality delicatessen, meat products and semi-finished products. The company Ordabasy Kus LLP is the first and the only enterprise in the Republic of Kazakhstan engaged in industrial production and deep processing of turkey meat [2,3].

Meat bread, in terms of technology, is a dish made on the basis of minced or chopped meat, which is moulded in the form of a loaf of bread. That is why meat bread has such an unusual name. The range of meat breads is constantly being updated and expanded. Meat breads are products like cooked sausage without casing, subjected to baking. Stuffing is baked in quadrangular metal moulds without casing, wrapped in paper or cellophane. Compared to cooked sausages, meat breads contain less moisture; have a denser consistency and a pleasant specific flavour due to the effect of high temperature during baking. Most meat breads have the same name, recipe and cut appearance as cooked sausages [4].

Provision of the population with functional meat products should be made taking into account the ever-increasing needs of consumers in providing the body with sufficient energy and with a high content of vitamins, minerals and antioxidants. In this direction, a significant role is assigned to the substantiation of the technology of obtaining combined and enriched meat products with functional ingredients of different origin (dietary fibres, vitamins, minerals and others) [5, 6].

On the basis of meat products, scientists and practitioners have determined that it is productive to create functional products by mutual substitution of some components from the formulation with raw materials of plant origin, including vegetables and their secondary products with biologically active valuable substances. In this sense, the use of agro-

industrial by-products as a natural and cheap source due to biologically valuable compounds, including antioxidants and mineral compounds, is economically and environmentally beneficial [7].

Thus, the aim of this work is to develop technology and study the quality of combined meat bread with the addition of powder from tomato waste.

Materials and research methods

Experimental samples of meat bread were prepared in the conditions of research laboratory "Food Engineering and Foodstuffs" of M.Auezov SKU and baked in the multifunctional thermo-chamber KTD-100.

Experimental studies of experimental samples were carried out using standard research methods. The composition of mineral substances of experimental samples was studied using scanning electron microscope JSM-6490LV with the system of energy dispersive microanalysis INCA Energy 350 and the system of structural and textural analysis of polycrystalline samples HKL Basic in the Testing Regional Laboratory of Engineering Profile "Structural and Biochemical Materials" of M. Auezov SKU. The main quality parameters of meat bread (pH, water activity, moisture content) depending on the amount of tomato powder were determined in the laboratory of innovative biomaterials and substances "Biotech" of the Faculty of Biotechnology of ITMO University (Saint-Petersburg).

Technological scheme and recipe for preparation of combined meat bread

Creation of meat bread with the addition of tomato powder was carried out according to the traditional schemes of making cooked sausage products. Technological scheme of preparation of combined meat bread consists of the following operations: preparation of tomato powder and flavouring additives, preparation of combined minced meat, shaping of semi-finished products, cooking of meat bread in the oven, storage and sale of the product. Recipe of preparation of combined meat bread is given in Table 1.

Table 1. Recipe of preparation of combined meat bread with tomato pomace powder

No	Raw material, g	Control	Sample 1, (5%)	Sample 2, (10%)	Sample 3, (15%)	Sample 4, (20%)
1	Lamb	315	312,5	310	307,5	305
2	Turkey	315	312,5	310	307,5	305
3	Chicken eggs	120	120	120	120	120
4	Fresh onions	84	84	84	84	84
5	Wheat flour bread	100	100	100	100	100
6	Water	60	60	60	60	60
7	Himalayan salt	6	6	6	6	6
8	Ground black pepper	2	2	2	2	2
9	Tomato pomace powder	-	5	10	15	20

The samples of minced meat prepared according to the recipe were tightly filled into pre-greased aluminium moulds and placed in a multifunctional thermo-chamber KTD-100 at 160-180°C for 1.5-2 hours, depending on the weight of the loaf. The baking process is considered complete when the temperature inside the loaf reaches 70 °C. The baked product is cooled at room temperature 6-10°C until the internal temperature of the loaf is equal to or less than 15°C. The cooled loaf is wrapped in cellophane or other packaging materials. Meat bread is stored in a refrigerated room at a temperature not exceeding 8°C and relative humidity of 75-80% for up to 5 days.

Finished samples of meat bread were examined for such indicators as organoleptic, physico-chemical and microbiological.

Literature review

Many scientists, Kazakhstani and foreign, are engaged in the study of the nutritional value and development of technology for the production of food products from the meat of various animals, including mutton and turkey with the addition of vegetable components [8-11].

Thus, Uzakov Y.M. et al. in the work of [12] investigate the biological value and chemical composition of experimental samples of mutton injected with a composition of brine from fresh pumpkin juice, tincture of goji berries, salt and water. The obtained results indicate that the chemical composition and nutritional value of experimental samples of national meat products from mutton is richer compared to the control, which is explained by the introduction of brine compositions.

Iskineeva A. et al. [13] used fat-soluble vitamin complex "Aevit" encapsulated with food oligosaccharide β -cyclodextrin (E459) as a functional ingredient for the development of technologies of functionally enriched meat product from mutton and ostrich meat. The final product has a pronounced lean taste, characterized by attractive organoleptic parameters: juicy and tender consistency, light brown colour and delicate meat smell.

In [14] the results of the study of a functionally enriched meat product with a biologically active additive are presented. Fat-

soluble vitamin E (α -tocopherol acetate) encapsulated with β -cyclodextrin was used as an ingredient. A functional meat product from mutton and turkey meat containing the inclusion complex " β -cyclodextrin: vitamin E" was developed.

Foreign scientists mainly devote their work to studying the effect of tomato products, including the antioxidant lycopene contained in tomatoes, on colour, carotenoid content, oxidation level, texture, organoleptic characteristics, as well as antimicrobial and antioxidant activity of cooked minced pork, conventional sausages, chicken sausages and others [15-19].

Due to the possibility of effective enrichment of meat semi-finished products with plant components with high biological value, the development of a scientific approach in this direction is of interest for use in the production of functional foods.

Results and discussion

Model formulations of meat bread were developed to determine the effect of tomato pomace powder on organoleptic, physicochemical and microbiological parameters. The recipe composition of meat bread consisted of fat lamb, turkey, chicken eggs, tomato pomace powder and spices.

Organoleptic parameters of product much more than the chemical composition and nutritional value, play a decisive role for the consumer, influence the choice of consumers and, ultimately, form their demand. Therefore, when studying the powder of the tomato pomace on the quality of meat bread, special attention was paid to organoleptic characteristics.

In order to establish the optimal composition of meat bread were studied model samples without vegetable raw materials - control and experimental samples with partial replacement of fat mutton. Thus semi-finished products with 5 % tomato pomace powder (sample No.1), 10 % tomato pomace powder (sample No.2), 15 % tomato pomace powder (sample No.3) and 20 % tomato pomace powder (sample No.4) were prepared. After heat treatment, organoleptic evaluation was carried out in accordance with GOST 33609-2015 Meat and meat products. Organoleptic analysis (Table 2).

Table 2. Quality assessment of combined minced meat breads by organoleptic indicators

Name of indicator	Control	Sample 1, (5%)	Sample 2, (10%)	Sample 3, (15%)	Sample 4, (20%)
Colour on the surface and on the cut	Pink	Pink	Saturated pink	Pleasant, with some red and yellow tones	Orange
Odour and taste	To standard, without extraneous tastes and odours	Close to standard	With a slight tomato flavour	Nice tomato flavour and odour, juicy	Sour bitter flavour, tart odour, dryish
Surface	Breads with a clean, smooth, dry, evenly toasted surface				
Shape	Rectangular trapezoidal				

The colour on surface and cut of the products containing tomato pomace powder differed significantly, with the amount of additive affecting the intensity of the colour on the cut. With the increase of the additive from 5% to 20%, the products became more saturated, and the proportion of red and yellow shades increased, thus the colour of sample No.4, (20%) became orange, which is not characteristic of these products (Figure 1). According to organoleptic indicators (colour, taste, juiciness) we chose the optimal

variant of added tomato pomace powder in the amount of 15%.

Physico-chemical characterisation of meat bread with tomato squeeze powder

After determining the optimal amount of vegetable additive in the amount of 15%, samples of meat bread were prepared and examined for the main qualitative parameters. All measurements were carried out in threefold repetition. The main physico-chemical parameters of 4 samples of meat bread with tomato pomace powder, (raw and after heat treatment) are shown in Table 3.



1-Control; 2- Sample 1, (5%); 3- Sample 2, (10%); 4- Sample 3, (15%)

Figure 2- Image of meat bread with the addition of different amounts of tomato pomace powder

Table 3. Value of pH, water activity (a_w), moisture content in meat bread samples

Name of indicator	Sample 1 Meat bread (raw) control	Sample 2 Meat bread (raw) (with 15% tomato powder added)	Sample 3 Meat bread (after heat treatment) control	Sample 4 Meat bread (after heat treatment, with 15% tomato powder added)
pH	6,26	6,14	6,37	6.27
a_w	0.800	0.766	0.750	0.701
W, %	71.5	70.3	62.18	60.87

Based on the results of the study of physicochemical characteristics of meat bread with tomato pomace powder, it was observed that the pH value and water activity (a_w) in the meat bread samples decreased consistently after the addition of 15% tomato powder. This improves the shelf life and safety of meat products as they are then more resistant to spoilage microorganisms. Also the

results obtained show that the vegetable additive in the form of tomato pomace powder reduces the free moisture content due to its partial binding by the powder.

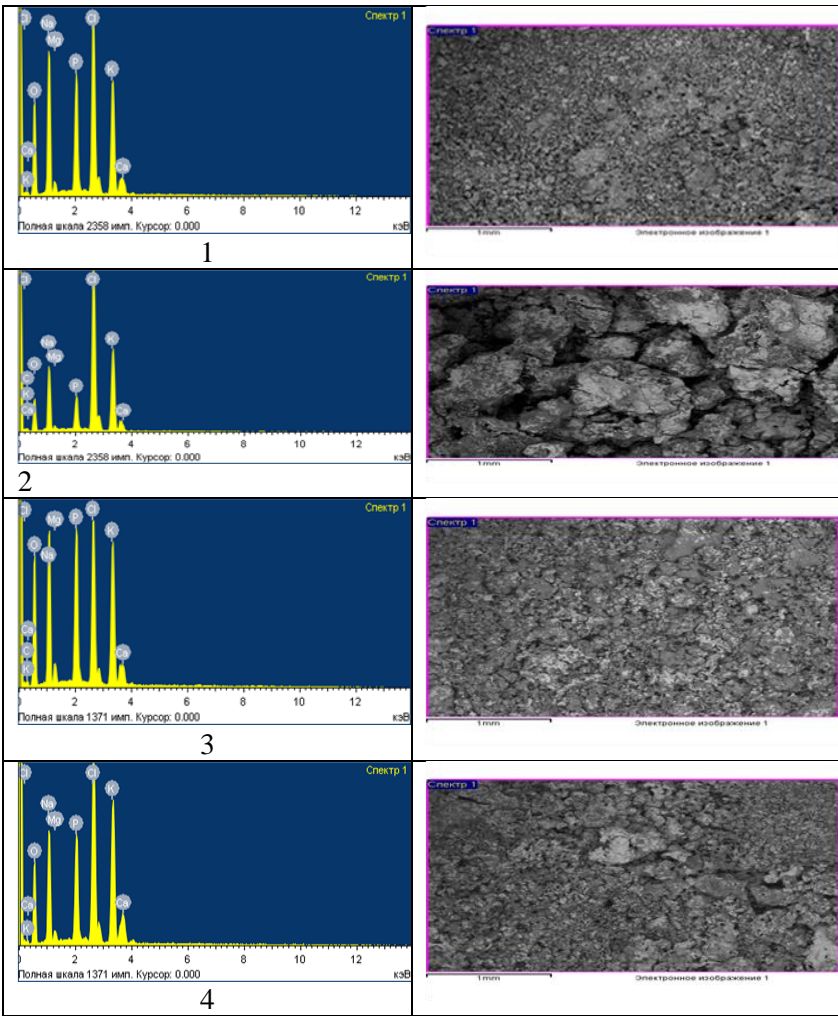
The results of the analysis of 4 samples of meat bread with the addition of different amounts of powder from tomato are shown in Table 4 and Figure 2.

Table 4. The content of mineral substances of meat bread with the addition of different amounts of tomato pomace powder

Element	Control	Sample 1, (5%)	Sample 2, (10%)	Sample 3, (15%)
C	6.35	8.78	9.35	10,23
O	35.20	26.77	36.79	34.54
Na	18.44	13.70	15.81	14.14
Mg	1.27	0.66	1.70	1.21
P	10.29	4.75	10.45	8.92
Cl	18.21	26.60	13.14	19.53
K	14.79	18.12	14.14	18.28
Ca	1.80	0.62	1.62	3.38

As can be seen from the table, in terms of mineral composition in the samples of meat bread with the addition of different amounts of tomato pomace powder, a number of essential mineral elements were found with a predominance of potassium (from 14.14% to 18.28%), phosphorus (from 4.75% to 10.45%). Of the other mineral elements, increased levels of calcium (0.62 -3.38) and magnesium (0.66- 1.70) were also determined in meat bread samples with the addition of different amounts of tomato pomace powder.

As a result of the study of all samples of meat bread with the addition of powder from tomato pomace after cooking revealed that the microbiological indicators: Quantity of Mesophilic Aerobic and Facultative Anaerobic Microorganisms, *Escherichia coli* group bacteria, *Staphylococcus aureus*, bacteria of the genus *Proteus*, pathogenic microorganisms, including salmonella, meet the normative indicators according to TR TS 021/2011.



1-Control; 2- Sample 1, (5%); 3- Sample 2, (10%); 4- Sample 3, (15%)

Figure 2. Electronic image of meat bread with the addition of different amounts of tomato pomace powder

Conclusion

According to the results of experimental studies, it can be concluded that the developed composition of meat bread recipes with high nutritional and biological value, due to the use of secondary raw materials in the form of powder from tomato pomace, and the application of processes with minimal energy consumption, is economically feasible. Especially since by-products of fruit and vegetable processing are considered cheap sources of natural biological compounds, including antioxidants, which have a positive effect on human health [20-22].

Innovative meat bread has excellent organoleptic characteristics and high quality properties, which will make it in demand among consumers. Enriched meat bread, in addition to the above advantages, is also a functional food product due to the high content of vitamins, protein, dietary fibre and minerals. In general, the developed technology of meat bread fully corresponds to the trends of today, namely in the field of healthy nutrition of the population of the Republic of Kazakhstan.

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СҮТҚЫШҚЫЛДЫ ӨНІМДЕРДІҢ САПА ПАРАМЕТРЛЕРІН МАТЕМАТИКАЛЫҚ МОДЕЛЬДЕУ

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Сүтқышқылды өнімдерінің оңтайлы сапа параметрлерін модельдеуге байланысты ғылыми тақырып аса өзекті болып табылады және халықты ағзаның пайдалы заттарға қажеттілігін қанағаттандыратын жоғары сапалы өнімдермен қамтамасыз ету бойынша қолданыстағы мемлекеттік бағдарламалар мен ұлттық жобалар жазықтығында ерекше орын алады. Компьютерлік математиканың сандық жүйелеріне негізделген есептеу әдістері рецептуралар мен параметрлерді модельдеуде ерекше мәнге ие, бұл арнайы және жаппай тамақтануға арналған сүтқышқылды өнімдерді өндіру процесіне барынша негізделген көзқараспен қарауға мүмкіндік береді. Бұл ғылыми мақалада пробиотикалық ашытқыларды қолдана отырып, түйе сүті негізінде әзірленген сүтқышқылды өнімдердің рецептурасы мен сапа көрсеткіштерін математикалық модельдеу нәтижелері келтірілген. Модельдеу зерттелетін процестің математикалық моделін құрастыруда жиі қолданылатын «қара жәшік» тұжырымдамасын қолдану арқылы жүзеге асырылады. Зерттеуді жоспарлау матрицасы 30 қайталанымнан тұрды және 100 л сүтті ашытуға қажетті барлық өзгермелі параметрлерді қамтыды (енгізілген пробиотикалық ашытқы мөлшері (0,1-0,3 кг), ашыту уақыты (4-12 сағат) және температурасы (30-34°C), қышқылдық (104-121°Т). Кіріс деректерін ескере отырып, сүтқышқылды өнім үшін әсер ету беті мен тең деңгейлі сызықтар анықталды, жеке көрсеткіштер үшін регрессия теңдеулері құрастырылды. Жүргізілген ғылыми жұмыстың нәтижесінде түйе сүті негізінде сүтқышқылды өнімдер өндіру үшін сапаның оңтайлы параметрлері анықталды: ашыту уақыты – 12 сағат, ашыту температурасы – 32 °С, сақтау мерзімі – 45 тәулік, бұл ретте қол жеткізілген қышқылдық – 116 °Т болды, нәтижесінде сүтқышқылды өнімнің ең жақсы органолептикалық көрсеткіштері сақталды, олар мүмкін 5 баллдың 4,8-іне бағаланды. Осылайша, модельдеудің бұл әдісі белгілі