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PROSPECTS OF AMARANTH USING IN THE BRINE SYSTEMS BASED ON URONATE POLYSACCHARIDES

The article is devoted to the problem of improving the nutritional value of meat snack products by improving the composition of marinades with amaranth oil and mixtures for injection such as amaranth protein hydrolyzate. The authors considered the reasons for the creation of improved meat snack products with increased nutritional and biological value. The prospect of using amaranth in the composition of brine systems (mixtures for injection, massaging and soaking) for the production of meat snack products has been substantiated. The chemical composition of analogue brine systems and systems with the inclusion of amaranth is given. Use in the composition of brine for the injection of well-digestible proteins of vegetable origin is based on the fact that, together with the total increase in the moisture content of salty model fermented meat systems they allow to regulate the mass fraction of protein in the composition of finished products. Adding to the brine composition of animal protein in the amount from 0,5 to 1% allows to get meat systems with stable structural and mechanical characteristics.

Keywords: meat snacks, uronate polysaccharides, brine systems, injection, amaranth.

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ПЕРСПЕКТИВИ ВИКОРИСТАННЯ АМАРАНТУ В РОЗСОЛЬНИХ СИСТЕМАХ НА ОСНОВІ УРОНАТНИХ ПОЛИСАХАРИДІВ

Стаття присвячена проблемі підвищення харчової цінності м'ясної снекової продукції за рахунок покращення складу маринадів маслом амаранту і сумішей для ін'єктування - гідролизатом протеїну амаранту. Авторами розглянуто причини, що призвели до необхідності створення покращеної м'ясної снекової продукції з підвищеною харчовою і біологічною цінністю. Обгрунтовано перспективу використання амаранту у складі розсольних систем (сумішей для ін'єктування, масажування та замочування) для виробництва м'ясной снекової продукції. Наведено хімічний склад аналогових розсольних систем і систем із включенням до складу амаранту.

Ключові слова: м'ясні снеки, уронатні полісахариди, розсольні системи, ін'єктування, амарант.

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ПЕРСПЕКТИВЫ ИСПОЛЬЗОВАНИЯ АМАРАНТА В РАССОЛЬНЫХ СИСТЕМАХ НА ОСНОВЕ УРОНАТНЫХ ПОЛИСАХАРИДОВ

Статья посвящена проблеме повышения пищевой ценности мясной снековой продукции за счет улучшения состава маринадов маслом амаранта и смесей для инъектирования - гидролизатом протеина амаранта. Авторами рассмотрены причины, приведшие к необходимости создания улучшенной мясной снековой продукции с повышенной пищевой и биологической ценностью. Обоснована перспектива использования амаранта в составе рассольных систем (смесей для инъектирования, массирования и замачивания) для производства мясной снековой продукции. Приведен химический состав аналоговых рассольных систем и систем с включением в состав амаранта.

Ключевые слова: мясные снеки, уронатные полисахариды, рассольные системы, инъектирование, амарант.

Introduction. The popularity of meat products, in particular meat snacks, occupies a leading place among Ukrainian consumers. Recently, the number of publications on the improvement of meat products technologies has considerably increased. Their result testifies to a number of technological and economic advantages over the existing analogues of meat semi-finished products and meat and sausage products.

The authors [1], for example, cite the results of an analytical study based on the study of auxiliary materials, nutritional supplements and ingredients for brines, minced meat and shells. This allows to obtain high organoleptic characteristics, a good digestibility of the edible part of the product, and, above all, a high degree of readiness for further processing or consumption. The added nutritional ingredients have a tendency to improve the quality and increase the yield of cooked meat products. This is a necessity in the case of supply to the enterprises of the meat processing industry of raw materials with obvious and numerical signs of deviation from the standards. The negative tendency of increasing the low-quality raw materials intended for the manufacture of meat products and meat snacks is primarily due to such unfortunately erratic phenomena as breeding achievements associated with the acute need to increase the rates of meat productivity, as well as stress factors that arise not only at the technological level, but also in the feed [2].

Nowadays, salted meat products belong to a group of delicatessen products and are quite popular. The assortment of snack meat products is widely represented by products made from beef, pork, lamb, horseradish etc. It is necessary to take into account the high quality of the input raw material and the main processes occurring with the meat salting in connection with the increase in demand for meat snack products.

This requires a comprehensive approach to the technological process. Firstly, it is necessary to make the right selection or regulation of raw materials, using innovative approaches related to the development of the composition of brine mixes [3]. Secondly, it is necessary to know perfectly the main changes occurring in the raw material during the biochemical processes associated with the stage of fermentation of the meat raw material in the marinade mixes both in the traditional dry method and in the wet, which is becoming popular [4].

Thirdly, to know ways to improve the water holding and moisture-absorbing capacity of meat products prepared for drying, by means of additional injection gel systems, in particular on the basis of uronate polysaccharides [5].

It should be noted that at each stage of meat snack production, it is recommended to add various types of food ingredients, which not only increase the quality indices, but also improve the biological value. Nevertheless, in spite of high value of the last indicator, given products require the enrichment of a number useful substances, which are not contained in natural raw materials. They include vitamins, minerals, food fibres, biologically active substances, such as flavonoids and antioxidants.

Such an approach to the production of meat snack products is relevant and effective, both in terms of the people's nutrition strategy, taking into account their taste preferences as well as in terms of the profitability of the proposed technologies.

A known method of wet marinating in emulsion mixtures using vegetable oils (in most of the rapeseed) and the addition of spices, salts and extracts of spicy plants allows to soften the fibers and prevent the emergence of pathogenic microorganisms. Vegetable oils have several important technological functions, in particular, protecting protein substances of meat raw material from the denaturizing action of organic acids, which are present in marinating mixtures, prevent untimely drying of products and are good extracts for aromatic substances and fat-soluble vitamins [6].

One of the ways to improve the quality of snack products from meat is the addition of new non-traditional types of plant materials. They contain a balanced complex of proteins, lipids, vitamins and minerals and have a high nutritional, flavoring and therapeutic and prophylactic properties. Amaranth is the most perspective type of non-traditional plant raw materials for the obtaining assortment of snack products

A special interest is the use of amaranth as a valuable ingredient that has a high nutritional (Tabl.1) and biological value (Tabl. 2).

Table 1. Nutritional value of amaranth, g /100 g

Proteins	Fats	Carbohydrates	Water	Food fibres
21,6	4,1	58,6	12,8	6,7

By amino acid score amaranth seeds hydrolyzate is very similar to breast milk, which is considered to be a standard (Table 2). Furthermore, fats, which are in the amaranth seeds, have a high content of polysaturated fatty acids and biologically active components. The composition of fat includes olein, linoleic, linolenic fatty acids. Lipid fraction contains up to 10 % of squalene hydrocarbon. This is an unique substance, that precedes the synthesis of triterpenes and steroids, including sterols and their derivatives. They are very effective in the treatment and prevention of atherosclerosis [9].

Table 2. Comparative analysis of amino acids score of amaranth seeds hydrolyzate and breast milk, %

Amino acid	Contents	
	Amaranth [7]	Breast milk [8]
Valine	4,9	5,13
Isoleucine	3,9	4,59
Leucine	6,76	9,91
Methionine	1,84	1,82
Phenylalanine	4,18	7,61
Tyrosine	2,71	
Threonine	3,69	5,06
Lysine	6,4	7,74
Alanine	4,54	4,45
Arginine	10,64	4,35
Asparagine	8,48	9,62
Glycine	8,12	2,88
Glutamine	19,69	17,21
Histidine	2,98	2,86
Proline	4,61	8,06
Serine	5,55	5,27

Solving of problem in general and its connection with important scientific or practical tasks. Thereby, taking into account the useful physiological and technological properties of amaranth seeds, it is possible to predict that its oil is included in the emulsion mixture, intended for marinating (massaging) meat products before fermentolysis and an amaranth seed protein hydrolyzate added to the gel mixture for pre-drying injecting, able to improve the quality and increase the yield of meat products and snacks on their basis.

The purpose of the work is the analyze of possibility using oil and amaranth seeds hydrolyzate in the composition of emulsion mixtures for massage (marinating) and brine systems based on uronate polysaccharides for injection in order to improve of technological characteristics of raw materials and increase the consumer properties of finished products, namely meat snacks.

Presentation of the main materials. It is necessary to create the model, that take into account all stages of production, quality indicators and functional properties of product, according to the modern ideas about the principles of "designing" food systems.

Models are best represented in the form of mathematical dependence. Such equations can accurately describe changes in mineral, vitamin, amino acid and fatty acid composition, taking into account the quota of raw materials used. This reduces the matrix of experiments in relation to the composition of products and analyzes only developed mathematical models.

Created recipes are based on the concept of rational nutrition, according to which the normal human life requires the income of an amount of energy and basic nutrients in the body that would be adequate to daily expenses. Modelling also allows to calculate strictly certain relationships between many nutritional factors, as proteins, fats, carbohydrates mineral and vitamin components [10]

Regardless of the used methods, the formulation and justification of the recipes involved the following stages:

• definition of requirements for ingredients and product in accordance with the task;

• selection of ingredients that provide the necessary properties of the product;

• determination of criteria and permissible limits (the smallest and largest fraction) of the ingredient in the recpes;

• search for the optimum ingredients in the recipes.

The task of calculating the optimal recipes was as follows:

• make a list of ingredients allowed for the production of beef based meat snacks;

• determine the basic characteristics of the control sample and each of the samples under study (moisture content, fat, protein, amino acids);

• establish the necessary mass of the resulting product, taking into account the quantitative ratios of the ingredients in the recipes, which allows to state that the finished product provides a set value of the optimization criterion.

The method of solving the task was, primarily, in the choice of the target function, the criteria of which were the balance of food and energy value. The food value was first determined during the construction of the model:

$$MP_a = \Sigma MP_{ai}; \quad (1)$$

$$MF_a = \Sigma MF_{ai}; \quad (2)$$

$$MC_a = \Sigma MC_{ai}; \quad (3)$$

$$EV = MP_a \cdot 4 + MF_a \cdot 9 + MC_a \cdot 4; \quad (4)$$

where MP_a – actual protein content in the finished product, g; MP_{ai} – actual protein content in the i-th ingredient, g; MF_a – actual fat content in the finished product, g; MF_{ai} – actual fat content in the i-th ingredient, g; MC_a – actual carbohydrate content in the finished product, g; MC_{ai} – actual carbohydrate content in the i-th ingredient, g; EV – energy value of finished product, kcal; *coefficients 4, 9, 4* – quantity of kcal, which are formed in the human body at oxidation of 1 g protein, 1 g of fat, 1 g of carbohydrates, respectively.

The assessment of the constraints on the main components was made taking into account the recommended daily allowance (RDA) [11–13].

Restriction criteria were set for the ideal protein and determined as a percentage of RDA for each amino acid.

If you need to get the protein content in the mix within certain limits (P_{min}, P_{max}), than the restriction on the content of amino acids is determined by the formulas 5 and 6:

$$A_{mink} = \frac{F_a \times P_{min}}{100} \quad (5), \quad A_{maxk} = \frac{F_a \times P_{max}}{100} \quad (6).$$

Where F_a – the amino acid the content, corresponding to the scale of FAO/WHO (or ideal protein for this product).

Calculations of the recipes versions under the chosen optimization criterion, which was determined in the first stage, and the established restrictions were implemented, performing the input of the initial data, the formation of a simplex-table, calculations on the computer. The ingredient composition and the expected values of product characteristics were determined as a result of calculations.

The limitation on the amaranth oil and amaranth protein hydrolyzate amount was due to the rheological changes of the emulsion and gel for injection on the basis of uronate polysaccharides. In the first case, there should be no dissection, in the second case - sedimentation of coagulated particles of polysaccharides and proteins macromolecular solutions.

The production verification of the substantiation of recipes results was carried out according to traditional technology. After making the real product and performing the assessment (measurement) of its characteristics, they were compared with the estimated values and control dishes. If the deviation of the characteristics did not exceed the permissible level (meaning, within the limits), then the technical documentation for the product was developed. If the deviations were above the permissible level, then showed the reasons that caused them. The errors in measuring the actual characteristics of the ingredients, incorrect assessment of the level of technological losses, inaccurate dosage of ingredients, etc were considered of them.

The purpose of the recipes optimization is the product's balance on the main nutrients, the maximum approximation to the following requirements of healthy eating.

Discussion of results. Compositions of multifunctional brines of colloidal systems for marinating, massaging and further injecting of meat raw materials were selected and calculated. These compositions allow you to get a high-quality product, as "Dried&Salted Snack" (Beef).

Determination of the quantitative composition of multifunctional brines of colloidal systems for marinating, massaging and further injecting was carried out by calculation using the principles of combinatorics. The stability of rheological, physico and chemical indicators was taken into account in this case.

The process of making snack products was in three stages:

I – marinating into the brine, that contain enzyme;

II – massaging in the emulsion brine mixtures with the amaranth oil addition;

III – injection with gel solutions based on uronate polysaccharides and enriched of amaranth seeds protein hydrolysate;

IV – drying in the infrared field.

The complex of components, that take part in the first three stages is given in the Table 3. It was used an unsaled meat raw materials with DFD classification during the research.

The meat salting had a preserving function at the beginning.

Simultaneous use of pepsidase with sodium chloride at salting and other salting ingredients, including extracts of spicy plants, stabilizes the color of meat raw material. During the biochemical and chemical reactions product becomes a specific taste and aroma. The principle of using instead of the plant part their extracts allowed increasing the environmental friendliness of the process, reducing the storage area and the amount of waste. The muscle tissue has swelled and its volume was increased during the salting. The water holding capacity was increased because proteolysis and protein salting out were carried out at reduced pH.

Diffusion and filtration processes took place at the first stage. The inorganic and organic salting ingredients come in deep into the meat at the same time. The number of centers for the binding of moisture decreases as a result of proteins coagulation. A part of moisture, extractive and protein substances, amino acids and other useful ingredients are lost from meat. These components should be stored as part of the finished product.

Therefore, at the second stage, the principle of massage was used in the same solutions that were formed at the end of the first stage. The amaranth oil was added to the meat juice that appeared at the end of the first stage in order to improve the composition, look of meat products and inhibition of moisture removal processes. The emulsion formed during this was used during massaging.

Massage lasted no more than 2,5 hours, since after this time the solubility of the proteins begins to decrease. The hydrophilicity of the meat products is reduced. n addition, prolonged mechanical processing can lead to significant destruction of meat structure. This will lead to unwanted additional moisture losses with dissolved substances in it. The method of preserving meat juice in the composition of sarcoplasmic proteins is necessary, since these proteins have enzymatic activity.

An adequate level of moisture in the product provides the process of ionization of sodium chloride in both the sarcoplasmic and myofibrillary proteins of DFD meat.

A nitrogen extractives, in particular, free amino acids accumulate according to this method, as a result of biochemical processes. Loss of free amino acids from the product is quite undesirable.

The method of maintaining free amino acids in the matrix of the gel based on the uronate polysaccharides composition was developed by us earlier [5].

It is known that pH affects the aroma of meat products. At pH 6,1–6,6 the taste and aroma are better than at pH 5,4–5,6. However, an increase in pH is undesirable because it will interfere with the biochemical processes and contribute to the emergence of pathogenic microflora and is dangerous for the second stage. Therefore, the addition of gels in the mixture for injection is definitely a rational solution for simultaneous rising pH.

Gels have a pH of 6,9–7,2, a significant number of centers for the formation of hydrogen bonds for the accumulation and maintenance of hydrophilic substances in the gel and finished product, in particular protein molecules and free amino acids, minerals.

The amaranth hydrolysates, incorporated into injection mixtures based on uronate polysaccharides, are also well kept in the matrix of gels due to the implementation of the van der Waals gravity forces and increase the amount of amino acids in the finished product.

The products got a tender consistency, became more delicious and acquired a higher digestibility level at the end of the third stage of salting. The addition into a brine for extrusion a mixture of uronate polysaccharides with amaranth seeds proteins hydrolysates significantly increases the yield and provides high consumer characteristics of meat snacks.

It was noted that only gels based on uronate polysaccharide addition into the injection solution forms a defect in the cut of products in the form of gel formations in local breakdowns of the muscle structure and in the myofibrillar space.

Such defects in ready-made dry snacks were not observed, in the case of the amaranth seeds protein hydrolysates addition for the correction of structural and mechanical characteristics and nutritional value regulation.

The control sample was DFD beef, with pre-marinating, fermentation and drying.

Sample 1 – beef DFD with pre-marinating, massage in solution with enzyme preparations and extracts of spicy plants, injection of a gel solution on the basis of the uronate polysaccharides.

Sample № 2 – beef DFD, with pre-marinating, massage in solution with enzyme preparations and extracts of spicy plants with the addition of amaranth oil, injection of a gel solution on the basis of the uronate polysaccharides.

Sample № 3 – beef DFD, with pre-marinating, massage in solution with enzyme preparations and extracts of spicy plants with the addition of amaranth oil, injection of a gel solution on the basis of the uronate polysaccharides, enriched of amaranth seed protein hydrolysate.

The samples before the treatment had a mass of 100 g, but before the drying, the mass differed, as there were processes of hydration of different intensity.

The moisture content in the finished snacks did not exceed 13%. The amount of intra-linked moisture in samples № 1, 2 was equal to 0,63% due to the binding of the uronate polysaccharides. In sample № 3 – 1,78% at the expense of binding of the uronate polysaccharides and amaranth protein hydrolysate.

Table 3 Optimization of the recipe composition of meat snacks

Name of ingredients, %	Virtual models of recipes «Beef snacks»			
	Control	1	2	3
Chemical composition, %				
Moisture	12,83	10,95	9,30	6,80
Fat	5,3	5,3	7,3	7,3
Protien	79,27	79,5	79,15	81,6
Undigestible sugars	0	2,1	2,1	2,1
Ash	2,6	2,15	2,15	2,2
Dry matter (DM)	87,17	89,05	90,70	93,20
Energy value, kcal	364,78	365,7	382,3	392,1
Amino acid composition, g				
Asparagine	8,18	8,20	8,26	9,05
Threonine	3,70	3,71	3,73	4,08
Serine	3,60	3,61	3,64	3,75
Glutamine	14,18	14,23	14,32	14,54
Glicin	4,34	4,36	4,39	4,54
Alanine	5,03	5,05	5,09	5,16
Valine	4,76	4,77	4,81	4,87
Methionine	2,08	2,09	2,10	2,12
Isoleucine	3,60	3,61	3,64	3,69
Leucine	6,84	6,86	6,90	6,99
Tyrosine	3,05	3,06	3,08	3,11
Phenylalanine	3,70	3,71	3,73	3,78
Histidine	3,28	3,29	3,31	3,35
Lysine	7,34	7,37	7,42	7,49

In tabl. 3 shows the results of beef meat snacks optimization enriched with amaranth oil during massaging and hydrolysing the amaranth protein during injection with gel solutions on the basis of uronate polysaccharides.

Conclusions and perspectives of further development of this direction. Studies have shown that 30 ml of gels based on a 2% solution of uronate polysaccharides containing 5% dry amaranth seed protein hydrolysate can increase the content of useful amino acids by almost 11% compared with the control sample. The developed approaches are able to regulate deficiencies of DFD type meat products and help to obtain more stable quality indices in finished products. The enrichment of useful substances and the use of the developed sequence of technological operations minimizes the syneresis of model meat systems during their storage and allows them to make meat snacks softer than the consistency of their control analogs.

During the tasting, it was found that meat snacks, the method of preparation of which is given in the article, have a painful taste, aroma, are softer, well-soaked with saliva and more original. The proposed method of meat snacks production makes it possible to produce them at food industry enterprises.

Use in the composition of brine for the injection of well-digestible proteins of vegetable origin is based on the fact that, together with the total increase in the moisture content of salty model fermented meat systems they allow to regulate the mass fraction of protein in the composition of finished products. Adding to the brine composition of animal protein in the amount from 0,5 to 1% allows to get meat systems with stable structural and mechanical characteristics.

Taking into account the high variability of the meat raw material properties, which depends on a number of factors (type of muscles, pH, durability and storage conditions, etc.), according to experimental data, it can be assumed that the content of vegetable protein in the composition of the injection mixture can vary from 5 to 10% to the weight of the gel on the basis of the uronate polysaccharides.

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