Method for production of ham products

S E Bozhkova¹, A S Zvorygina¹, I F Gorlov¹², M I Slozhenkina¹², O P Shakhbazova³, A K Natyrov⁴ and A S Miroshnik²

¹ Volgograd State Technical University, Lenin avenue, 28, Volgograd, Russian Federation
² Volga Region Research Institute of Manufacture and Processing of Meat-and-Milk Production, Rokossovskogo street, 6, Volgograd, Russian Federation
³ Don State Agrarian University, Krivoshlykova, 24, Persianovka village, Oktyabrsky district, Rostov region, Russian Federation
⁴ Kalmyk State University named after B.B. Gorodovikov, A.S. Pushkin street, 11, building 1A, Elista, Republic of Kalmykia, Russian Federation

E-mail: bozhkova@mail.ru

Abstract. The article is devoted to development of functional meat products made from beef obtained from crossbred bulls by Red Steppe cow breed with Kazakh white-headed bulls. The main raw material in the design of the ham recipe was beef obtained from crossbred bulls ¾ blood of Kazakh white-headed breed. Its functional and technological parameters were follows: pH was 6.73; dry matter content - 29.55 5%; fat content - 9.20%; protein content - 19.45%; water-holding capacity - 0.47-0.48 kg of water per 1 kg of raw materials. The possibility of introducing a biologically active additive in the form of lactulose powder, as well as vitamins and minerals, is being considered. The developed products have pleasant taste and aroma, that is specific to this type of product, elastic consistency, characterized by high quality indicators. Cost price of ham samples for elderly nutrition - 420.0 and 420.8 rubles per 1 kg, that confirms feasibility of this development.

1. Introduction

In recent decades, there has been a noticeable increase in the part of elderly population in Russia. Developments in field of identifying effective measures to preservation of health and prevent diseases of this part of population are relevant and have social, economic and political significance. For such a large part of the population, the most important factor of healthy old age is a balanced diet.

Meat industry has a variety of ways to purposefully change qualitative characteristics of food raw materials in order to give it necessary set of functional properties (in vivo preparation, introduction of functional food additives into the product during processing of raw meat, etc.) [1-8].

Currently, lactulose is considered the most effective prebiotic and classic bifidus factor. Due to its physiological properties, lactulose can be used both independently and in combination with other biologically active substances to prolong their action. It has been found that lactulose supports the growth of a wide variety of lactic acid bacteria.

Functional food products of gerodietic orientation are intended for elderly people, who currently comprise more than 40 million people in the Russian Federation, their share in total population exceeding 20% [9].
One of the most popular products of this category of population is ham – product made from pieces of boneless meat, salted using massaging, as well as ripened and cooked in order to create a monolithic structure and elastic consistency of prepared product.

Enrichment of beef-based ham with food additives such as lactulose in combination with calcium citrate and ascorbic acid allows, on the one hand, to adjust functional and technological properties of minced meat systems, on the other hand, gives prepared product a prophylactic focus [10-14].

2. Goals and objectives
The purpose of this work is to analyze the feasibility of producing ham from beef obtained from hybrids of bulls of the Kazakh white-headed breed for elderly nutrition.

Research objectives: to substantiate and select the ingredient composition; to develop an original product formulation and product production technology.

3. Methods and materials
In the research, raw meat was obtained from crossbred bulls of ¾ Kazakh white-headed breed (PZK named after Lenin in the Surovikinsky district of the Volgograd region). According to previous studies, meat of bulls from this crossbreed had the best functional and technological indicators (pH level of meat, indicators of nutritional and biological value) [15-17].

The work was carried out on the basis of the educational-scientific center «Kolbasnyy tseh Technolog» of Department of food production technologies of Volgograd State Technical University and integrated analytical laboratory of Volga Region Research Institute of Manufacture and Processing of Meat-and-Milk Production.

Stages of the work: selection and preparation of raw materials, production of samples of ham products, evaluation of organoleptic and physico-chemical parameters to determine quality of the obtained products, optimize formulations and develop the products technology in accordance with outline the study (figure 1).

The objects of the research: beef from crossbred bulls of ¾ Kazakh white-headed breed, broiler chickens meat, lactulose powder, calcium citrate, ascorbic acid and samples of ham, produced on the basis of these components using nitrite salt and a complex food additive according to generally accepted technology [15-17].

Optimisation of the products formulations was carried out using MS Office 2019 package.

Selection and preparation of samples for laboratory research, as well as analysis of the main parameters of quality were carried out according to generally accepted methods; energy value - by calculation method. Product safety was ensured by the implementation of the technological process and compliance with expiration dates (Technical Regulations of the Customs Union «On the safety of meat and meat products» - TP TC 034/2013).

The calculation of economic efficiency of production of fried sausages according to different formulations was carried out on the basis of actual costs and prices for 2020 in counting on the experimental workshop.
Figure 1. Outline of the study.

4. Results and discussion

4.1 Analysis of functional-technological properties of beef obtained from cross-breed bulls of Kazakh white-headed breed

As main raw material in designing ham formulations, we used beef obtained from crossbred bulls of ¾ Kazakh white-headed breed, with following functional-technological parameters: pH was 6.73; dry matter content - 29.55%; fat content - 9.20%; protein content - 19.45%; water-holding capacity - 0.47-0.48 kg of water per 1 kg of raw materials.

4.2 Development of ham product formulation and technology

To optimize functional-technological properties of beef in production of ham, minced meat was made from poultry meat (broiler chickens). Also, formulation included such ingredients as calcium citrate, ascorbic acid, lactulose, complex food additive «Russian Muscat FS». 
In course of the research, technology of ham products, that includes following stages: acceptance of raw materials, grinding in a meat grinder, massaging, maturing in a refrigerator, filling casings, sludge, heat treatment, cooling, quality control, packaging, labeling and product realization was developed. Formulation of the processed products is presented in table 1. The technological diagram of production of the experimental samples of ham products is shown in figure 2.

**Table 1.** Experimental ham formulations.

| Raw materials, spices, materials     | Norm per kg, per 100 kg of unsalted raw materials |
|-------------------------------------|-----------------------------------------------|
|                                     | control sample | experimental sample 1 | experimental sample 2 |
| Beef trimmed 1 grade                | 40.0           | 40.0                  | 40.0                  |
| Broiler chicken meat                | 60.0           | 60.0                  | 60.0                  |
| TOTAL unsalted raw meat             | 100.0          | 100.0                 | 100.0                 |
| Nitrite salt                        | 2.0            | 2.0                   | 2.0                   |
| Complex food supplement «Russkaya muscat FS» | 0.8            | 0.8                   | 0.8                   |
| Lactulose                           | -              | 0.93                  | 0.93                  |
| Calcium citrate                     | -              | -                     | 0.40                  |
| Ascorbic acid                       | -              | 0.12                  | 0.12                  |
| Water                               | 25.0           | 25.0                  | 25.0                  |

Calcium reserves in the body must be constantly replenished, since in the process of vital activity it tends to be removed from the animal's body. It is calcium citrate, in contrast to carbonate, chloride or gluconate, is the safest drug for this purpose. It is better absorbed by stomach, regardless of acidity level in it.

It is known that ratio of calcium in meat raw materials to phosphorus is about 1:20, and in sausages, as a result of the introduction of phosphates, this ratio is much higher. The introduction of 0.4% calcium citrate into the ham formulation allowed to balance the ratio of calcium-phosphorus to 1.00:1.25 and at the same time give the product necessary consistency.

Since lactulose significantly increases absorption of calcium, its use with calcium citrate has synergic effect.

The use of lactulose in a complex with ascorbic acid in formulation has a positive effect on color formation of the products: these food additives lead not only to oxidative changes in sodium nitrite with reduction to nitric oxide, but also to a change in the potential of chopped meat, including Mb, MetMb, NO, etc., and increasing its reactivity.

**4.3. Determination of organoleptic indicators**

The obtained samples of ham products were characterized by high organoleptic characteristics: straight loaves, with a clean dry surface, with a heterogeneous structure (minced chicken contains inclusions of beef pieces), elastic consistency, light pink color of varying intensity, with a ham smell, moderately salty pleasant taste, without perceptible foreign tastes and smells. According to presented profilogram of comparative assessment of organoleptic parameters, the experimental samples had a slight advantage, probably due to a slightly more intense red color of the minced meat and a more delicate texture due to the addition of lactulose and ascorbic acid (figure 3).

**4.4. Analysis of physical-chemical parameters and energy value**

Analysis results of main quality parameters of experimental samples are presented in table 2.
**Table 2.** Product quality analysis results.

| Parameter                                      | Control sample | Experimental sample 1 | Experimental sample 2 |
|------------------------------------------------|----------------|-----------------------|-----------------------|
| Mass fraction of sodium chloride, % (table salt) | 2.0            | 2.0                   | 2.0                   |
| Protein content, %                              | 21.1           | 20.9                  | 20.5                  |
| Fat content, %                                  | 10.7           | 10.9                  | 10.6                  |
| Mass fraction of sodium nitrite, %, no more than | 0.003          | 0.003                 | 0.003                 |
| Energy value of 100 g, kcal                     | 180.7          | 181.7                 | 177.4                 |

**Figure 2.** Technological scheme of ham products.
control sample; experimental sample 1; experimental sample 2

Figure 3. Profilogram of organoleptic indicators of the samples 1-unsatisfactory; 2-satisfactory; 3-good; 4-very good; 5-excellent.

The results indicate high quality of the experimental samples compared to the control sample. Addition of lactulose powder and other additives did not have a significant effect on fat and protein content and energy value, at the same time made it possible to impart functional properties to the products.

4.5. Analysis of ham products cost price

On the basis of technology of the produced experimental ham products, an assessment of economic efficiency of ham production was carried out by calculating cost price (table 3).

| Table 3. Calculation of cost price of samples. |
|-----------------------------------------------|
| Raw material | Price for 1 kg, rubles | amount, kg | Price, rubles control sample | experimental sample 1 | experimental sample 2 |
|---------------|-------------------------|------------|-------------------------------|-----------------------|-----------------------|
| Main raw material |                         |            |                               |                       |                       |
| Beef          | 330                     | 0.4        | 132                           | 132                   | 132                   |
| Meat broiler chicken | 280                 | 0.6        | 168                           | 168                   | 168                   |
| TOTAL for main raw materials | 610 | 1 | 300                           | 300                   | 300                   |
| Additional raw materials |         |            |                               |                       |                       |
| Nitrite salt  | 250                     | 0.02       | 5                             | 5                     | 5                     |
| Complex food supplement «FS Russian Muscat» | 1600 | 0.008 | 12.8                          | 12.8                  | 12.8                  |
| Lactulose     | 4053                    | 0.0093     | -                             | 37.7                  | 37.7                  |
| Calcium Citrate | 174.4                 | 0.004      | -                             | -                     | 0.7                   |
| Ascorbic acid | 500                     | 0.0012     | -                             | 0.6                   | 0.6                   |
| Water (m³, rub.) | 23.2                | 25.0       | 5.8                           | 5.8                   | 5.8                   |
| Sum of additional raw materials | 6577.4 | 25.0425 | 23.6                          | 61.9                  | 62.6                  |
| Auxiliary materials | -                   | -         | 20                            | 20                    | 20                    |
| Total         |                         |            | 343.6                         | 381.9                 | 382.6                 |
| Product yield, % no less than | - | - | 90.0                          | 90.0                  | 90.0                  |
| Cost price, rubles per kg of prepared food product for raw materials and materials | - | - | 378.0                         | 420.0                 | 420.8                 |
The cost price of the ham control samples based on beef from crossbred bulls of ¾ Kazakh white-headed breed was 378.0 rubles per 1 kg. At the same time, cost price of samples produced according to the developed from the same raw meat formulations for elderly diet, respectively 420.0 and 420.8 rubles per 1 kg, that at the moment, taking into account other costs of manufacturer and distribution network, is average for the Russian market.

5. Conclusions
For development and production of meat product samples was used beef from crossbred bulls ¾ of Kazakh white-headed breed. Technology of functional meat products - ham for elderly nutrition according to recipes using lactulose powder, calcium citrate, ascorbic acid, provides for similar stages inherent to production of ham products according to traditional formulations.

The developed products have a pleasant taste and flavour, that are characteristic of this type of product, an elastic consistency, and high quality indicators.

The expediency of introducing lactulose in combination with ascorbic acid and calcium citrate into the formulation of sausages in order to improve their functional and technological properties has been proven.

Cost price of the ham samples for elderly diet was 420.0 and 420.8 rubles per 1 kg, that confirms feasibility of this development.

References
[1] Maksimenko A, Lyude A and Nishiumi T 2020 Texture-modified foods for the elderly and people with dysphagia: Insights from Japan on the current status of regulations and opportunities of the high pressure technology IOP Conference Series: Earth and Environmental Science 548(2) 022106
[2] Gorlov I F et al. 2016 Method for producing environmentally safe meat in radioactively contaminated area Asian Journal of Animal Sciences 10(1) 99-105
[3] Gorlov I F, Slozhenkina M I, Bozhkova S E, Grigoryan L F and Andryushchenko D S 2020 Method for producing sausages, licopine enriched III International Scientific Conference: AGRITECH-III-2020: Agribusiness, Environmental Engineering and Biotechnologies. Krasnoyarsk Science and Technology City Hall of the Russian Union of Scientific and Engineering Associations Krasnoyarsk Russia 82047
[4] Gorlov I F, Bozhkova S E, Danilov Y D, Anisimova E Y, Mosolova N I and Starodubova J V 2020 Analysis of efficiency of production of sausage products using non-traditional vegetable raw materials III International Scientific Conference: AGRITECH-III-2020: Agribusiness, Environmental Engineering and Biotechnologies. Krasnoyarsk Science and Technology City Hall of the Russian Union of Scientific and Engineering Associations Krasnoyarsk Russia 82032
[5] Sha L and Xiong Y L 2020 Plant protein-based alternatives of reconstructed meat: Science, technology, and challenges Trends in Food Science and Technology 102 51-61
[6] Pinton M B, dos Santos B A, Lorenzo J M, Cichoski A J, Boeira C P, Campagnol P C B 2020 Green technologies as a strategy to reduce NaCl and phosphate in meat products: an overview Current Opinion in Food Science 40 1-5
[7] Boeira C P et al. 2020 Phytochemical characterization and antimicrobial activity of Cymbopogon citratus extract for application as natural antioxidant in fresh sausage Food Chemistry 319 126553
[8] Alexeev A, Alexeeva T, Enaleva L, Tupolskikh T and Shumskai N 2020 Prospects for the use of protein-carbohydrate complex based on mung bean seeds in the functional meat products technology E3S Web of Conferences 175 08004
[9] Madyanova V V, Kakorina E P and Kloko B T A 2020 The characteristics of mortality of population older than able-bodied age in the Russian Federation in 2012-2018 Problemy sotsial'noi gigieny, zdravoookhraneniia i istorii meditsiny 28(4) 523-8
[10] Khramova V N, Bozhkova S E, Yaschuk B M 2020 Intensification of concentration solutions technologies in the food industry *Izvestia VSTU* 3(238) 49-52

[11] Gorlov I F, Slozhenkina M I, Bozhkova S E, Pilipenko D N, Natyrov A K, Mosolova N I, Knyazhechenko O A and Mosolova D A 2019 Meat and vegetable pate: optimization of functional and processing properties and quality parameters *Indo American Journal of Pharmaceutical Sciences* 6(8) 14998-5005

[12] Kuryshchev O O, Mosolova N I, Gorlov I F and Danielyan I S 2017 Improving the production technology of cooked sausage products using vegetable raw materials *Bulletin of the Lower Volga Agro-University Complex: Science and Higher Professional Education* 3(47) 191-5

[13] Nasonova V V, Lebedeva L I and Veretov L A 2013 New national standards for cooked sausages and liverwurst *Meat technologies* 1(121) 24-9

[14] Federal norms and regulations in the field of industrial safety 2008 *The physiological requirements for energy and nutrients for various groups of the population of the Russian Federation* (2.3.1.2432-08)

[15] Krishtafovich V I and Krishtafovich D V 2018 Assortment and quality requirements for boiled sausages according to various regulatory documents *Commodity expert on food products* 3 16-21

[16] Gorlov I F, Nikolaev D V, Sherstyuk B A, Slozhenkina M I and Gishlarkaev E I 2019 Features of the formation of quality indicators ram edilbay breed in arid conditions *IOP Conference Series: Earth and Environmental Science Conference on Innovations in Agricultural and Rural Development* 012035

[17] Gorlov I F, Nikolaev D V, Kaydulina A A, Grishin V S and Mosolova D A 2019 The efficiency of crossbreeding of Red Steppe cows and bulls of the Kazakh white-headed breed for meat productivity increase and beef quality improvement *Animal Husbandry and Fodder Production* 4(102) 98-105