Gerodietetic meat product

I F Gorlov¹,², M I Slozhenkina¹,², A G Zolotareva³, O A Knyazhechenko¹ and D A Mosolova¹

¹ Volga Region Research Institute of Manufacture and Processing of Meat-and-Milk Production, Volgograd
² Volgograd State Technical University, Volgograd

E-mail: genzol5@mail.ru

Abstract The article considers the replaceability of a part of raw meat with plant material, in particular, flax meal and pumpkin in order to develop a product for elderly people. For the same purpose, the proposed formulation was added with calcium citrate produced according to a new technology intended to enrich the product with calcium—one of the most important macroelements. The study has selected optimal amount of plant ingredients introduced that did not spoil the sensory properties of the product. The main physicochemical parameters, i.e., weight fractions of protein and fat and amino acid composition, were examined. It was concluded that the developed formulation makes it possible to obtain a low-calorie high-protein calcium-enriched product intended for gerodietetic nutrition. Replacing a part of raw meat with plant materil can also reduce the finished product cost.

1. Introduction

The issue of increasing the life expectancy has remained relevant for a long time. Today, the average life expectancy is not longer than 85 years in the world and do not exceed 80 years in many developed countries, such as Russia, China, and the United States. Many external and internal factors affect the health and life expectancy of a person. These are ecology, lifestyle, working conditions, bad habits and, first of all, dietary factor. The human body requires a large number of nutrients, with their essential amount depending on the age and gender of the person. The diet of the elderly is imposed with special requirements. Now, foods for particular nutritional uses, such as products for infants and health are often found on the shelves of stores. Gerodietetic nutrition is not given much attention to [1]. However, older people require a special diet. Many physiological and morphological age-related changes increase the need for some nutrients and decrease for others. A proper diet contributes to the prevention of many diseases, including nutritional ones, helps prolong active life, and increase the average life expectancy of a person [2].

In order to develop a new product that meets the gerodietetic requirements, literary sources were analyzed, the dietary reference intake was studied for this category of people, and meat and plant raw materials were selected. The paste was chosen due to its delicate texture that is preferable for the elderly. Rabbit meat has several advantages compared to other meat types and was chosen as raw meat. It is low-calorie, contains easily digestible proteins and polyunsaturated fatty acids (PUFAs), such as omega-3 and omega-6 [3, 4]. Plant raw material in the composition of the meat product was used to improve sensory and nutritional properties and reduce the cost of the product [4, 5, 6]. Flax meal and pumpkin were chosen as plant materials. Like rabbit meat, flax meal is a source of PUFA and contains a large
amount of protein [7, 8]. The pumpkin’s dietary fiber improves digestion and removes harmful substances from the body. Eggs, butter, onions, salt, black pepper ground, and nutmeg ground were also added to the recipe to improve sensory properties of the product. The applied calcium citrate is a bioavailable source of calcium—an element essential for older people in greater quantities, because with age, calcium is reduced in the bones, which makes them brittle. Therefore, the recommended daily intake of calcium is 1000-1200 mg for the elderly. In order to provide the body with a bioavailable form of calcium, scientists at the SSI NIIMMP developed a new technology of the calcium citrate production that uses a 10% solution of citric acid and calcium carbonate in a ratio of 1.5-1.6:1 and obtained a patent “A method of calcium citrate production” No. 2703719 dated 04/18/2018 [7]. Its calcium content in the dry matter is 24.1%. Three g of the additive ensure the calcium daily value for 72.3%. Calcium citrate is used in food industry as an alternative to phosphate to increase the moisture-binding capacity of minced meat, which leads to an increase in product yield [9].

2. Research methods
The investigation involved several stages of analysis. At the first stage, Test samples with various percentages of plant ingredients were produced. Sensory evaluation of all samples found the best sample. Then, the physicochemical properties of the selected sample were evaluated in comparison with the Control. To examine the physicochemical parameters, sampling was conducted according to GOST R 51447-99. The weight fraction of total protein was determined according to GOST 25011-81, using the “Keltran” complex to determine nitrogen and protein by the Kjeldahl method. The weight fraction of fat was studied according to GOST 23042-2015. The amino acid composition was determined using the Aracus amino acid analyzer according to the instructions.

3. Results
To select the optimal composition of the formulation, several Test samples with different contents of components were produced. The percentage of plant ingredients in the obtained samples are presented in table 1.

| Plant ingredients | Plant ingredients content, % |
|-------------------|-----------------------------|
|                   | Test I | Test II | Test III |
| Flax meal         | 15     | 20      | 25       |
| Pumpkin           | 15     | 10      | 5        |

Figure 1. Sensory properties of samples under study.
The sensory evaluation noted Test II for best sensory properties in comparison with other samples. Test I was orange and watery due to the high content of pumpkin, non-standard for paste. Test III was too sandy because of high content of flax meal. The evaluation results are shown in the profilogram in figure 1.

At the next stage, the physicochemical parameters of the chosen Test sample were evaluated in comparison with Control that contained no flax meal or pumpkin. First of all, the protein content was analyzed, since protein is an important nutrient in the daily diet. The protein content was 18.3% in the Test sample and 17.0% in Control sample. The difference was due to the replacement of a part of raw meat with flax meal that contained a large amount of protein (36 g per 100 g of raw material). Lipids belong to main nutrients in the daily diet. The lipid content was 10.2% in Test sample and 11.3% in Control sample. This difference was due to the replacement of a part of meat with vegetable raw materials.

| Indicator                     | Sample  |
|-------------------------------|---------|
| Weight fraction of protein, % | Test    | Control |
| Weight fraction of fat, %     | 18.3±0.2 | 17.0±0.2 |
| Weight fraction of fat, %     | 10.2±0.4 | 11.3±0.4 |

Thermal and mechanical technological impacts on raw material decrease the biological value of a product [9]. Therefore, to produce the product, there were used gentle processing modes, such as blanching meat raw material and steaming vegetables. To assess the biological value, the amino acids content was analyzed, and its proportion in the daily intake rate was calculated. The calculation results are presented in table 3.

| Amino acid                  | Amino acid content in paste, mg / 100 g | Consumption rate, mg / day | Percentage of daily intake, % |
|-----------------------------|----------------------------------------|-----------------------------|-------------------------------|
| Valine                      | 684                                    | 2500                        | 27.36                         |
| Leucine + Isoleucine        | 1904                                   | 6600                        | 28.85                         |
| Lysine                      | 927                                    | 4100                        | 22.61                         |
| Methionine                  | 412                                    | 1800                        | 22.89                         |
| Threonine                   | 571                                    | 2400                        | 23.79                         |
| Tryptophan                  | 215                                    | 800                         | 26.88                         |
| Phenylalanine               | 862                                    | 4400                        | 19.59                         |
| Alanine                     | 634                                    | 3000                        | 21.13                         |
| Arginine                    | 1211                                   | 6000                        | 20.18                         |
| Histidine                   | 318                                    | 2000                        | 15.90                         |
| Glycine                     | 641                                    | 300                         | 213.67                        |
| Proline                     | 689                                    | 5000                        | 13.78                         |
| Serine                      | 487                                    | 3000                        | 16.23                         |
| Tyrosine                    | 523                                    | 3000                        | 17.43                         |

The essential amino acid score was also determined by comparison with the WHO FAO reference protein. The limiting amino acid was methionine; its amino acid score was 64.32%. The calculation results are presented in table 4.

| Amino acid                  | Amino acid content in paste, mg / 100 g | Amino acid content in reference protein, mg / 100 g | Amino acid score, % |
|-----------------------------|----------------------------------------|----------------------------------------------------|--------------------|
|                           |                                        |                                                    |                    |

Table 2. Weight fractions of protein and fat in product.

Table 3. The amino acid content in product, mg/100 g of product.

Table 4. Amino acid score.
The balance of the essential amino acids in the product was evaluated according to the coefficient of the amino acid composition utility of the protein that was calculated by the formula 1:

\[ U = \frac{\sum A_i \cdot C_{\min}}{\sum A_i}, \] (1)

where \( A_i \) is the content of the \( i \)-th amino acid, mg/100 g of protein; 
\( C_{\min} \) is the minimum score of an essential amino acid; and 
\( C_i \) is the speed of the \( i \)-th essential amino acid.

The difference coefficient of amino acid scores (DCAS) shows the average excess of the amino acid score of essential amino acids compared to the lowest scores of any irreplaceable amino acid. DCAS shows an excessive amount of essential amino acids that are not used for plastic needs, and was calculated by the formula 2:

\[ DCAS = \frac{\sum C_i - C_{\min} n}{n}, \] (2)

where \( C_i \) is the amino acid score of the \( i \)-th amino acid; 
\( C_{\min} \) is the minimum amino acid score; and 
\( n \) is the amino acids number.

The biological value of the protein was calculated by the formula 3:

\[ BV = 100 - DCAS \] (3)

The utility coefficient of the amino acid composition of the protein was 0.71. The paste’s DCAS was 32.0%, and its biological value was 68.0%. Thus, these values indicated a sufficiently high biological value of the protein product.

4. Conclusion

The developed formulation was noted for improved sensory properties, an increase in protein content, and a decrease in the weight fraction of fat. These values were achieved mainly by replacing a part of raw meat with plant material. Thus, the new formulation made it possible to obtain a low-calorie product enriched with functional calcium intended for the nutrition of the elderly. The introduced plant components allowed reducing the production cost; the calcium citrate not only enriched the product with this macroelements, but also increased the yield of the finished product.

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References

[1] Gorlov I F, Fedotova G V, Slozhenkina M I and Mosolova N I 2020 The meat products supply of population in Russia Lecture Notes in Networks and Systems 73 311-8
[2] Novikova M V and Dudnik T L 2012 Development of specialized products of gerodontetic nutrition Service in Russia and abroad 2 56-61
[3] Skurikhina M N 1987 Reference tables of the content of amino acids, fatty acids, vitamins, macro-
and microelements, organic acids, and carbohydrates Book 2 (Moscow: VO Agropromizdat) p 360

[4] Cullere M and Dalle Zotte A 2018 Rabbit meat production and consumption: State of knowledge and future perspectives Meat Science 143 137-46

[5] Tiensa B E, Barbut Sh and Marangoni A G 2017 Influence of fat structure on the mechanical properties of commercial pate products Food research international 100 558-65

[6] Gorlov I F, Fedotova G V, Glushchenko A V, Slozhenkina M I and Mosolova N I 2020 Digital Technologies in the Development of the Agro-Industrial Complex Lecture Notes in Networks and Systems 87 220-9

[7] 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 06 14998-15005

[8] Bilska A, Waszkowiak K and Blaszyk M 2018 Effect of liver pate enrichment with flaxseed oil and flaxseed extract on lipid composition and stability Journal of the science of food and agriculture 98 4112-20

[9] Aslanova M A, Ustinova A V and Govor I A 2011 Calcium-containing additives used in production of cooked sausages for pregnant women Meat industry 2 12-5