Producing of meat products using statistical evaluation of dietary types of meat

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Abstract. The article calculated the indicators of the coefficient of imbalance of the amino acid composition, the difference in the amino acid score and the biological value of proteins in dietary meat raw materials. Significant differences in the content of essential amino acids in different parts of the carcasses of the selected dietary meat raw materials were determined using the analysis of variance of a one-way uneven complex. In 2010, ideas to increase the life expectancy of citizens of the RF and improve its quality reached a new level – with the adoption by the Government of the RF of a number of strategic documents – «The Doctrine of food security of the Russian Federation until 2030»; «Fundamentals of state policy of the Russian Federation in the field of healthy nutrition of the population»; and etc. The main priority in solving the problem of the formation of the concept of a healthy lifestyle in Russia, citizens of Russia consider compliance with the principles of proper and nutritious nutrition. State measures to promote a healthy lifestyle for the population of Russia are consistent with the global concept of health promotion, according to which citizens participate in maintaining and strengthening their own health.

1 Introduction

The formation of a competitive Russian food industry, which will include new production, logistic and marketing solutions based on digitalization, network market models, customization of products and services, biotechnologies and resource efficiency will bring personalized nutrition to a new level. Personalization of food products is one of the priorities in the concept of the «roadmap» approved by the expert commission for the review of the FoodNet market roadmap dated 11.27.2020. Until now, the model of food production is based on the effect of scale – the bulk of products on store shelves belong to the category of general consumption. Not so long ago, manufacturers began to popularize products enriched with functional ingredients, however, these products also have a common focus – people of young, middle, elderly and senile ages [1, 2].

The principles of proper nutrition for the population of the age group 60 years and older is the main way to maintain a healthy lifestyle (37.7 %) [3], therefore, the most relevant is the development of meat-based herodietic products using scientifically based principles for

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the use of dietary types of meat raw materials and methods of designing food products that balance the diets of elderly and senile people.

The purpose of this study is to study the biological value of dietary meat raw materials proteins.

2 Materials and methods

In order to determine the biological value of proteins of various types of dietary meat raw materials, the amino acid composition was determined, guided by the research methodology presented in GOST 34132-2017 Meat and meat products. Method for determining the amino acid composition of animal protein. To determine the pressure of essential amino acids, to calculate the coefficient of imbalance of amino acid composition (hereinafter CRA), the differences in amino acid pressure (hereinafter RAS) and biological value (hereinafter BC) were guided by the principles and methods of designing food formulations (using MS Office). The determination of significant differences in the content of essential amino acids in different parts of the carcasses of the selected dietary meat raw materials was carried out by means of a dispersion analysis of a one-factor uneven complex.

3 Results and discussion

The technology of meat products for herodietic nutrition implies a radical change in the production process, in order to provide each individual consumer with an individual product (created taking into account the characteristics of DNA, microbiome and other features of the body – non-infectious, chronic diseases). The scientific substantiation of the need for food and plastic components, overcoming many diseases associated with a lack of vitamins, essential amino acids, trace elements, etc. were carried out by domestic scientists – A.M. Brazhnikov, V.A. Dadali, N.I. Dunchenko, A.I. Zharinov, Yu.A. Ivashkin, V.A. Isakov, N.N. Lipatov, A.B. Lisitsyn, A.A. Pokrovsky, I.A. Rogov, Tutelyan V.A., S.B. Yudina, etc.

Based on the theory of balanced nutrition, various diets have been created for most groups of the population, taking into account physical exertion, environmental and other living conditions.

For the organization of a balanced rational nutrition of the elderly, it is necessary to take into account the age classification approved by the Congress of Gerontologists and Geriatricians.

With age, the biosynthesis and activity of digestive enzymes decreases, the processes of absorption of substances weaken. This may cause a disruption in the supply of essential components to the tissues. A decrease in the motor activity of the muscular walls of the digestive tract leads to a violation of the act of defication. Reducing the acidity of gastric juice contributes to the development of putrefactive microorganisms in the digestive canal. This increases the load on the liver, where the toxic compounds absorbed from the intestine, formed by putrefactive microflora, are neutralized. A decrease in the outflow of bile along with a weakening of the excretory function of the intestine and a decrease in redox processes leads to a delay in cholesterol in the body and the development of atherosclerosis [3, 4, 5]. An excessive amount of cholesterol accumulates in the blood, which is deposited in the vascular walls and leads to the development of atherosclerosis, which reduces the blood supply to all organs and systems, causing a lack of oxygen in the tissues [4, 5, 6].

When making up a diet for the elderly, it is necessary to include easily digestible foods along with stimulants of motor activity of the intestinal walls, as well as substances that counteract the accumulation of toxins, including cholesterol. The recommended energy value for elderly and senile people should be 1900-2300 kcal.

Due to the weakening of assimilatory processes, elderly people need a sufficient amount of proteins - 1.2–1.0 g / kg of body weight (in the absence of some chronic non-communicable diseases of the heart, liver and / or kidneys). Sources of proteins should be dairy products, meat dishes from lean meats.

Low-fat, easily digestible meat raw materials include veal, chicken or broiler chickens, rabbit meat, etc. With a decrease in protein content in the diet of the elderly compared to the norm (1.2-1.0 g/ kg), the body's resistance to infections decreases and the nitrogen balance are disturbed. However, excessive protein intake increases the load on the heart, liver, and kidneys.

When taking into account the biological value of protein components, the most widely used indicators and criteria developed by academicians N.N. Lipatov (ml) and I.A. Rogov, based on the development of the Mitchell-Block principle. Using this principle, a number of indicators were formulated that allow us to evaluate the amino acid composition and its balance in the simulated product [5, 6, 7]. The widely used ones include the coefficient of utility of an essential amino acid, the coefficient of rationality of the amino acid composition. To assess the protein quality of various food parts of the studied meat raw materials, the following characteristics were used in the article:

1. Biological value (BV, %), reflecting the quality of the protein, including the degree of balance of its amino acid composition [9, 10].
2. The coefficient of imbalance of amino acid composition (CRA), numerically characterizing the imbalance of essential amino acids in relation to the physiologically necessary norm (standard). The smaller the value of the color, the higher the quality of the protein [9, 10].

Table 1 shows the calculation of the amino acid score, which was carried out by determining the ratio of each essential amino acid in the studied protein of meat raw materials to its content in the standard, using a scale approved by the committee of the World Health Organization (WHO).

Table 1. Comparative analysis of amino acid fast % of meat raw materials for the production of meat products for the nutrition of elderly and senile people.

Name of essential amino acids	Rabbit					
	Individual value	**Deviation of the individual from the average**	**Individual value**	**Deviation of the individual from the average**	**Individual value**	**Deviation of the individual from the average**
valine	250.62	-0.78	251.71	-1.87	247.2	+2.46
isoleucine	122.63	-0.38	123.1	-0.85	121.03	+1.22
leucine	172.92	-0.54	173.67	-1.29	170.56	+1.82
lysine	273.93	-0.84	275.15	-2.06	270.18	+2.91
methionine + cystine	110.77	-0.34	111.16	-0.73	109.35	+1.08
threonine	139.81	-0.44	139.29	-0.08	139.02	+0.41
tryptophan	153.55	-0.47	154.29	-1.21	151.40	+1.68
phenylalanine + tyrosine	58.69	-0.18	58.89	-0.38	57.94	+0.57
Turkey						
valine	159.28	+1.38	161.67	-1.01	161.04	-0.38
isoleucine	43.84	0.38	44.4	-0.2	44.43	-0.21
leucine	130.48	+0.68	132.44	-1.28	131.9	-0.74
lysine	184.06	+1,59	186.84	-1,19	186.06	-0,41
methionine + cystine	98.46	+0.85	99.85	-0.54	99.63	-0.32

threonine	75.0	+0.65	76.04	-0.39	75.9	-0.25
tryptophan	168.72	+1.46	170.83	-0.65	170.98	-0.8
phenylalanine + tyrosine	290.77	+2.52	295.23	-1.94	293.87	-0.58
Broiler chickens						
valine	28.19	0	28.02	-0.17	28.37	-0.18
isoleucine	11.43	0	11.34	+0.09	11.53	-0.1
leucine	17.86	0	17.96	-0.1	17.77	+0.09
lysine	22.54	0	22.42	+0.12	22.66	-0.12
methionine + cystine	160.3	0	159.44	+0.86	161.16	-0.86
threonine	159.66	0	158.81	+0.85	160.52	-0.86
tryptophan	860.43	+0.01	855.85	+4.59	865.05	-4.61
phenylalanine + tyrosine	17.38	0	17.27	+0.11	17.49	-0.11

According to the principles of rational nutrition of practically healthy elderly people, the study was conducted among dietary meat raw materials. The study revealed: rabbit, turkey and broiler chicken meat proteins are rich in essential amino acids, limiting amino acids are absent.

The quality of the protein was assessed by its amino acid composition (essential amino acids) compared with the amino acid composition (essential amino acids) standard sample.

To assess the adequacy of protein components of meat raw materials, it is important to calculate the biological value of dietary protein. The biological value of protein in meat raw materials is associated with the degree of balance of the amino acid composition in accordance with the physiological needs of the body, as well as with the digestibility of protein [10, 11].

Calculations coefficients of utilitarianism and rationality (CUR) for certain types of meat raw materials were carried out. The CUR coefficient shows the average value of the excess of the amino acid score of essential amino acids compared to the lowest level of the score of the essential amino acid.

The biological value (BV) of food protein was determined by the formula 1:

$$BV=100-CUR, \%\quad (1)$$

The data presented in Table 2 reflect the degree of balance of the amino acid composition of the protein of dietary meat raw materials.

Table 2. Protein balance of dietary meat raw materials.

BV of three repetitions	**Rabbit**	**Deviation of the individual from the average**	**Turkey**	**Deviation of the individual from the average**	**Broiler chickens**	**Deviation of the individual from the average**
$BV_{1п}$	93.185	+0.026	79.634	-0.176	54.516	-0.003
$BV_{2п}$	93.383	-0.171	79.478	-0.02	54.764	-0.251
$BV_{3п}$	93.066	+0.146	79.263	-0.195	54.258	+0.254
Amino acid number (Δ three repetitions)	75.19		62.32		135.06	

Thus, the results of the study of the nutritional and biological value of rabbit meat, turkey and poultry meat show the prospects of using this dietary meat raw materials in nutrition and in food production technologies for the elderly and senile.

Also, as part of the study, a variance analysis of a one-factor uneven complex was carried out, below is a fragment of the calculation using the example of valine content in various parts of a turkey carcass (thoracic, lower leg and thigh).

Two hypotheses are put forward: zero (there are no significant differences between the average values in the general aggregates, therefore, part of the carcass does not significantly affect the level of the amino acid valine) and alternative (there are significant differences between the average values in the general aggregates due to the influence of part of the turkey carcass [12]) (Formulas 2):

$$H0 : \widetilde{x1} = \widetilde{x2} = \ldots \widetilde{xn},\ H0 : \widetilde{x1} \neq \widetilde{x2} \neq \ldots \widetilde{xn} \quad (2)$$

where, H_0 is the null hypothesis, $\tilde{x}_{(1/2/n)}$ – are the average values in general aggregates

Table 3. One-dimensional significance criterion.

One-dimensional significance criterion for «Valine content». Sigma-limited parametrization. Decomposition of the hypothesis					
	SS	**Degree of freedom**	**MS**	**F**	**p**
Intercept term	30.415225	1	30.415225	30415225.0	0.000
Type of meat raw materials	3.003782	2	1.501891	1501891.0	0.000
Failure	0.000006	6	0.000001	-	-

where, SS is the intra–group variability; MS is the mean square; F is the Fisher criterion; p is the actual significance of the criterion F

The volume of variation (W) caused by other random factors is equal to:

Wgross = Wfactor + Wrelic.

Wfactor = 3.003782

Wrelic. = 0.000006

Wgross. = 3.003788

Variance by factor S $factor_2$ = 1.501891

Residual variance S $relic_2$ = 0.000001

true value F – criterion is equal to 1501891.0

The significance of the calculated criterion was 0.0 %, which is lower than the 5.0 % area that we accepted. Therefore, the null hypothesis about the equality of sample averages in general aggregates should be rejected. We accept an alternative hypothesis. With a probability level of 0.95, it can be argued that there are significant differences between the part of the turkey carcass in terms of the content of the essential amino acid – valine [12].

A dispersion analysis was carried out on the content of each essential amino acid for three types of meat raw materials under study. The significance of the criteria was below 5.0 %, therefore, an alternative hypothesis is accepted for all sample averages in general aggregates, and with a probability level of 0.95, the authors claim that there are significant differences between the parts of all three types of meat raw materials (according to the essential amino acids contained) [12].

4 Conclusion

Calculations of the coefficient of differences in amino acid score, amino acid number and biological value of proteins in the studied raw materials were carried out according to the fundamental indicators proposed by RAS academicians I.A. Rogov and N.N. Lipatov, and the methodology presented by FAO WHO. Based on the calculations, conclusions were drawn: all the raw meat presented for the study has a high biological value, but the highest value (93.211) is rabbit meat; the amino acid number, which shows the quality of protein, is

higher in broiler chicken meat – 135.06. Based on the results of the dispersion analysis of a one–factor uneven complex, with a probability of 0.95, it can be argued that there are significant differences in the content of amino acids in various parts of the carcasses of the meat raw materials under study – rabbit meat, broiler chicken and turkey.

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