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Amino Acid Profile of Meat of Specialized Beef Breeds.

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ABSTRACT

The article presents the research results of amino acid profile of beef obtained from bull-calves of Charolais, Aberdeen Angus and Hereford specialized beef breeds. The purpose of the research was a comparative study of the biological value of muscle tissue proteins in terms of their amino acid profile. The test was conducted in the framework of a comprehensive study of young cattle used for beef production in the Krasnodar Territory. 18-month old bull-claves were the target sample for this research. The experimental groups, each with 15 animals, were chosen based on the analogues principle. Feeding was carried out in accordance with the zootechnical standard. Analyzed samples were taken from the meat cut prepared from the right semi-carcass, as well as from the rib eye cross section between the 12th and 13th ribs. Analysis of amino acids was conducted in analyzed samples with the capillary electrophoresis system. The comparison was carried out in accordance with the reference or ideal protein on a FAO/WHO (Food and Agricultural Organization / World Health Organization) scale. The data obtained suggested that in meat and cut of various beef breeds no significant difference was found in terms of amino acid profile. A slight decrease in glycine, serine, proline and histidine, compared with those in other breeds was observed in Hereford breed. Analysis of the ratio between essential and nonessential amino acids in different breeds also did not reveal significant interbreed differences. A polynomial curve was almost identical for all tested breeds. When evaluating experimental groups in terms of the amino acid profile of proteins and their ratio in rib eye, no differences were observed as well, while their biological value and protein digestibility was very high. Beef of 18-month-old bull-calves corresponds to the highest category in terms of amino acid profile.

Keywords: beef cattle, Charolais, Aberdeen Angus, Hereford, bull-calves, amino acids, proteins, beef production.

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INTRODUCTION

One of the main issues in the agricultural sector of the economy is the increase of meat production and providing the population with this valuable nutrient. In this case the main focus should be on the cattle and beef production [2, 4, 12]. Meat and meat products should make up a significant share in the human diet [13]. This is because they are the main sources of biologically valuable proteins, fats, carbohydrates, as well as a whole range of minerals, vitamins and extracts that are necessary for the successful functioning of the organism [1, 17]. It is known that each breed is characterized by its unique protein composition [8], therefore the aim of our research was to carry out comparative study of the biological value of proteins with regards to the amino acid profile in muscle tissue of bull-calves of different breeds [3, 15].

MATERIALS AND METHODS

The test was conducted in the framework of a comprehensive study of a young cattle beef strain used for beef production in the Krasnodar Territory.

The 18-month-old bull calves of specialized beef breeds, namely, Charolais, Aberdeen Angus and Hereford, served as the research target. The experimental groups, each with 15 animals, were chosen based on the analogues principle. Feeding was provided in accordance with the zootechnical standard, recommended by All-Russian Research Institute of Animal Husbandry. The butchering was carried out according to GOST P54915-2011 and GOST P31494-2012. Samples were selected in accordance with GOST P51447-99 and GOST P55445-2013 from the rib eye cross section between the 12^{th} and 13^{th} ribs.

Analysis of amino acids was conducted on the analyzed samples using the capillary electrophoresis system “Kapel-105” according to the M-04-38-2009 technique. The comparison was carried out according to the reference or ideal protein on a FAO/WHO scale. Determination of protein was carried out according to GOST P25011-81.

DISCUSSION AND RESULTS

The amino acid profile is the main factor for biological value of protein-containing products [13]. The value of meat as a protein product is determined primarily by a balanced amino acid profile [7, 9]. The amino acid profile of a protein is an important indicator, which can be used to evaluate the biological value of meat [5, 6, 10, 11].

The amino acid profile, of proteins in muscle tissue of bull-calves in the experimental groups, was studied with the partition chromatography method and is presented in Figs. 1 and 2.

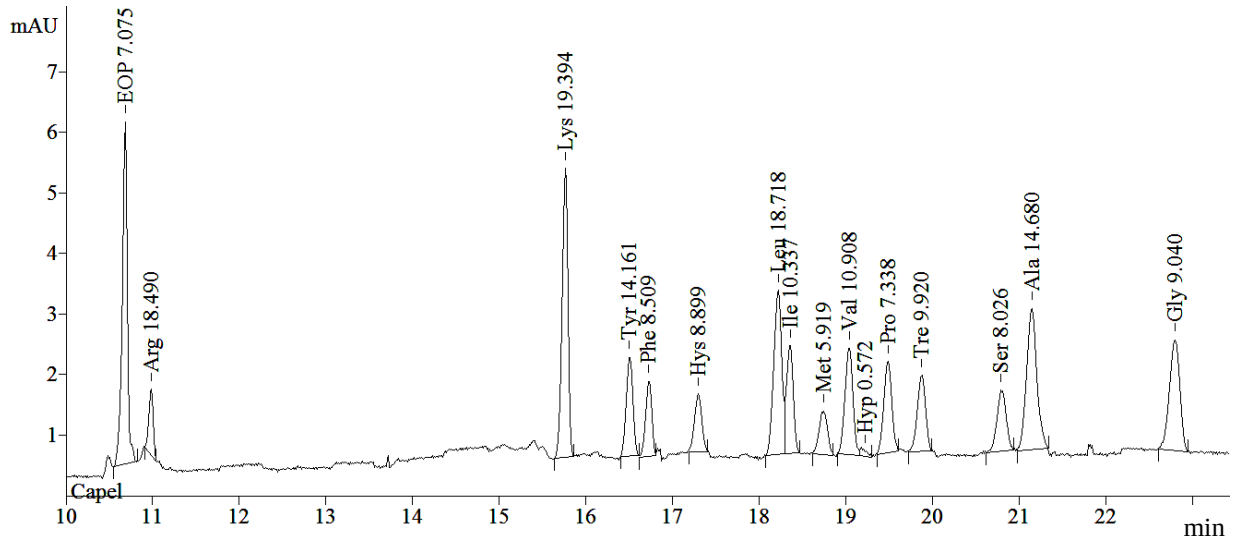

Figure 1. Chromatogram of amino acids of the rib eye after acid hydrolysis (Aberdeen-Angus breed, individual animal #1948).

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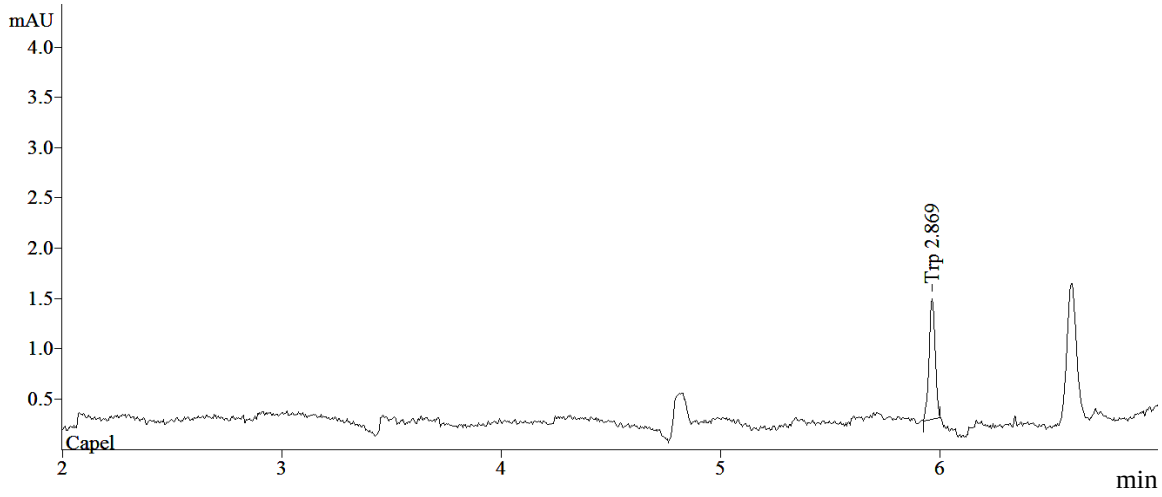

Figure 2. Chromatogram of the rib eye tryptophan after alkaline hydrolysis (Aberdeen-Angus breed, individual animal #1948).

Table 1 shows the amino acid profile in the muscle proteins studied.

It is obvious that there is no significant difference in the amino acid profile of muscle proteins of different breeds. There is just a slight decrease in glycine, serine, proline, and histidine in Hereford breed compared to other breeds.

Table 1. Amino acid contents in muscle protein, mg/100 g of tissue (n=15)

Indicator	Cattle Breed		
	Aberdeen Angus	Charolais	Hereford
Essential amino acids			
Lysine	1698.8	1658.4	1626.1
Leucine	1522.6	1577.6	1522.5
Valine	1051.4	1080.7	1063.7
Isoleucine	936.5	925.2	946.0
Threonine	984.1	987.8	1000.8
Phenylalanine	932.0	921.6	906.1
Methionine	587.2	545.4	536.4
Tryptophan	267.5	273.9	257.5
Nonessential amino acids			
Arginine	1744.7	1853.7	1795.4
Alanine	1585.8	1552.0	1552.0
Glycine	960.3	972.8	884.9
Serine	901.7	888.0	801.0
Proline	801.9	802.2	758.7
Histidine	794.9	797.1	740.5
Tyrosine	620.3	680.3	659.0
Cysteine	198.9	152.8	251.2
Oxyproline	62.3	58.7	60.2
Tryptophan/ Oxyproline ratio	4.3	4.7	4.3

To determine the nutritional value of the meat, the ratio of two amino acids, namely, tryptophan and oxyproline was calculated. In this ratio tryptophan characterizes the content of native protein, while oxyproline designates imperfect albumen.

The biological value of proteins is understood as availability not only a sufficient amount of essential amino acids, but also their given proportion. The closer is this proportion of proteins to that of the human body, the better, since it provides the complete utilization of amino acids for synthetic purposes. The violation

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of balance in amino acid profile of dietary protein leads to disruption of self-proteins synthesis, shifting the dynamic equilibrium of protein anabolism and catabolism towards the predominance of body's self-proteins breakdown, including protein-clinging enzymes [14, 16].

Analysis of the essential and nonessential amino acids ratio in different cattle breeds also revealed the lack of significant interbreed differences (Figs. 3 and 4). The polynomial curve was almost identical in all breeds.

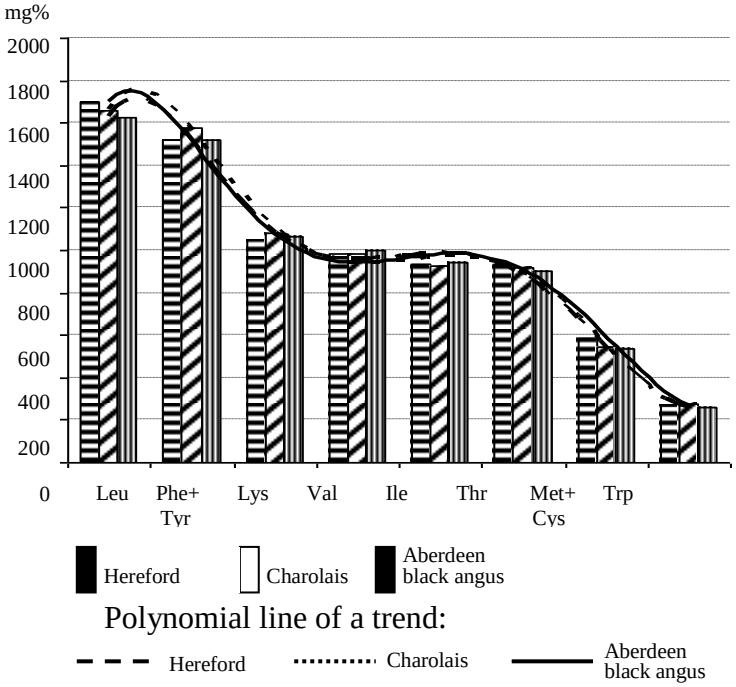

Figure 3. The essential amino acids ratio in muscle proteins.

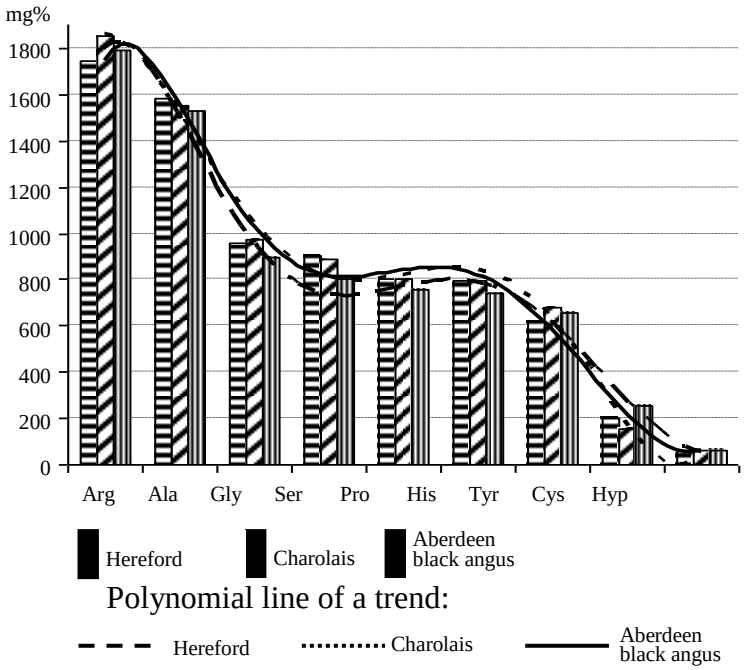

Figure 4. The nonessential amino acids ratio in muscle proteins.

The amino acid score (AAS) is an indicator of the biological value of a protein, representing a percentage ratio of a certain essential amino acid in the investigated protein to the same amino acid contained in ideal protein. The amino acid, which defines the biological value of the protein, is the one with a minimal score. The amino acid score shows the limit for using a given type of nitrogen, contained in the protein, for

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plastic ("building") purposes. The excess amount of other amino acids, contained in the protein, is not used for synthetic needs, though can be used as a source of nonspecific nitrogen, or for the body's energy needs. In the studied proteins, no deficiency of essential amino acids was observed during the tests (Table 2).

Table 2. Amino acid score of the investigated proteins (n=15)

Amino acid	FAO/WHO standard, mg/g	Content in muscle, mg/g	Score, %
Aberdeen Angus breed			
Lysine	55	85.8	156
Leucine	70	76.9	110
Isoleucine	40	47.3	118
Valine	50	53.1	106
Threonine	40	49.7	124
Phenylalanine + Tyrosine	60	78.4	131
Methionine + Cysteine	35	39.3	112
Tryptophan	10	13.5	135
Charolais breed			
Lysine	55	82.10	149
Leucine	70	78.10	112
Isoleucine	40	45.80	114
Valine	50	53.50	107
Threonine	40	48.90	122
Phenylalanine + Tyrosine	60	79.30	132
Methionine + Cysteine	35	38.60	110
Tryptophan	10	13.56	136
Hereford breed			
Lysine	55	80.10	146
Leucine	70	75.00	107
Isoleucine	40	46.60	116
Valine	50	52.40	105
Threonine	40	49.30	123
Phenylalanine + Tyrosine	60	77.10	128
Methionine + Cysteine	35	38.80	111
Tryptophan	10	12.68	127

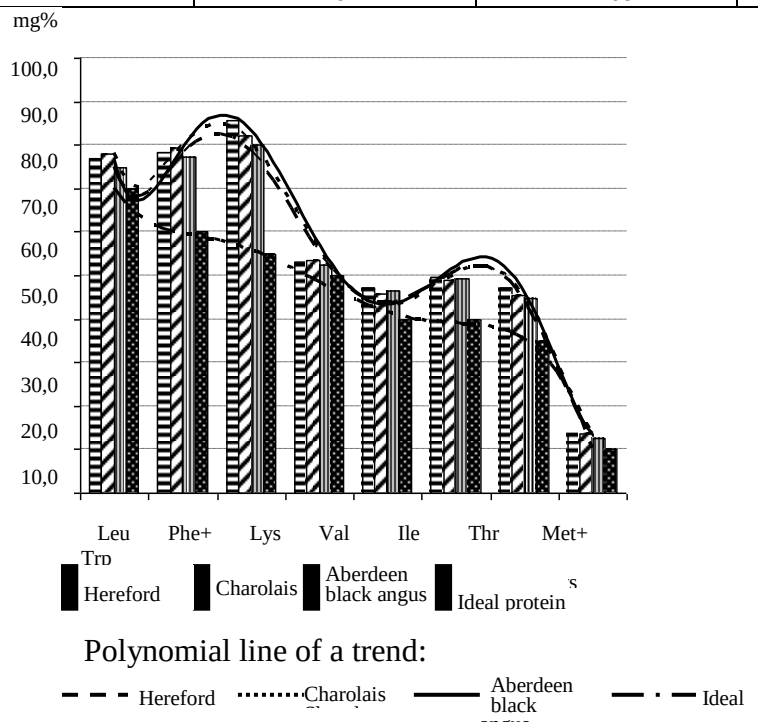

Figure 5. The proportion between the essential amino acids in muscles and the perfect protein.

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To fully utilize the amino acids, they should be well-balanced in consumed protein. However, it may happen that the amount of some amino acids could exceed standard quantities.

Comparing the amino acids amount and proportion in muscle protein with ideal protein (Fig. 5), we can see that there are two sharp maximums on the diagram, which correspond to the phenylalanine and lysine as well as to threonine and methionine. An excess amount of these amino acids is not consumed for synthetic needs, however it's used in other types of metabolism (carbohydrate, fat, and energy).

The maximum use of amino acids for synthetic needs is determined by the minimum score of one of the amino acids. Numerically it is characterized by the rational coefficient (utility or digestibility coefficient) of the amino acid profile (U). Ideally it is equal to unity and is calculated by the formula:

$$U = C_{\min} \sum_{j=1}^{n} (a_j A_j) / \sum_{j=1}^{n} A_j \ , \qquad (1)$$

The coefficient of comparable redundancy of the essential amino acid content (σ) characterizes the total mass of essential amino acids not used for anabolic purposes, even if contained in such amounts of protein of estimated product, which is equivalent to 100 grams of standard protein in terms of their potentially recoverable content. Ideally, U equals to zero.

$$\sigma = \frac{\sum_{j=1}^{n} (A_j - C_{\min} \cdot A_{3j})}{C_{\min}} \text{, where} \qquad (2)$$

$C_{\min}$ – is the minimum score of essential amino acids of evaluated protein relative to the physiological norm (standard), unit fraction;

a_j – is the utility coefficient of j-*th* essential amino acid;

A_j – is the mass fraction of j-*th* essential amino acid in raw meat, g/100 g of protein;

C_j – is the score of j-*th* essential amino acid of evaluated protein relative to the physiological norm (standard), unit fraction;

A_{3j} – is the mass fraction of j-*th* essential amino acid, corresponding to physiologically essential norm (standard), g/100 g of protein.

The qualitative estimation of compared proteins through formal indicators is that the higher the values of *U,* or the smaller the values of *σ*, the better is balance between essential amino acids and the more rationally they can be used by the body. Such formalization allows us to estimate quantitatively the proportion of essential amino acids in a particular protein product, which due to the imbalance between each other, a shortage or excess, can be used for the biosynthesis of nonessential amino acids or for energy purposes. Based on the score, we calculated the biological value of muscle protein (Table 3).

Table 3. Biological value of muscles proteins.

Indicator	Breed		
	Aberdeen Angus	Charolais	Hereford
The coefficient of amino-acid score difference (CAAS)	17.88	15.83	15.64
Biological fullmouthed, %	82.12	84.13	84.36
Utility (digestibility) coefficient, U	0.86	0.87	0.88
Coefficient of comparable redundancy, σ	5.97	5.11	5.22

According to the data presented in Table 3, all indicators of the biological value of the protein are similar to each other. Nevertheless, they are somewhat lower for the Aberdeen Angus breed.

CONCLUSIONS AND SUGGESTIONS

Thus, the evaluation of meat-cut and meat of the rib eye, obtained from bull-calves of Aberdeen Angus, Charolais and Hereford beef strains, did not reveal significant differences in terms of their amino acid profile and the proportion of proteins. The biological value and protein digestibility is very high in all tested breeds. Thus, we can conclude that the beef of 18-month-old bull-calves meets the requirements for high quality meat.

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