Nutritional value and environmental safety of bulls meat of the dairy direction

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Abstract. The authors present the results of research, according to the comparative assessment, food and biological value of beef from the purebred bulls of the Holstein breed belonging to different lines. The genetic potential of animals had a certain impact on high-quality indicators of the resulting meat raw materials. It has been established that the maximum amount of protein in the long muscle of the back was in the bulls of the reflective line, respectively, 0.53 and 0.8% compared with the same indicator of other animal lines. Culinary and technological indicators of meat studied groups are defined. The calculation of the amino acid ski was above 100% in all experimental groups, which indicates the usefulness of the obtained meat raw materials. Intergroup differences are noted on the most optimal content of essential amino acids, which slightly affected the biological value of meat.

1. Introduction
One of the main food products for the population of our country is beef, due to the content in it of the required amount of protein of animal origin. The value of meat is determined by its chemical composition, namely the content of proteins, fats, vitamins, macro and microelements. The biological value of proteins of animal origin is undeniable due to the balanced amino acid composition and, accordingly, better assimilation by the human body [1, 2, 3, 4, 5].

At the same time, it should be noted that beef production lags behind the level of its consumption. If according to the norms, according to the development of the Institute of Nutrition of the Academy of Medical Sciences, it is necessary for each person to consume 40 kg of beef per year, then at present this norm is half satisfied.

Therefore, at present, the question of finding additional sources for increasing beef production in our country remains open. One of these sources can be dairy and combined cattle, and primarily the Holstein breed, which has a large distribution area in various regions of our country [6].

2. Materials and methods
The aim of our research was a comparative assessment of the nutritional and biological value of meat obtained from bulls of the Holstein breed of German selection of different linearity.
The experimental part of the work was carried out at LLC "Agricultural Enterprise "Donskoe", Volgograd Region. Three groups of Holstein gobies belonging to different lines were selected for the experiment: Reflection Sovering 198998 (group I), Vis Back Aydial 933122 (group II) and Montvik Chieftain 933122 (group III), 10 heads each. After removing the bulls from fattening at the age of 13 months, a control slaughter of 3 heads from each group was carried out.

The control slaughter of animals was performed to study the beef production. The chemical composition of the eye muscle of loin was examined in accordance with the guidelines. The content of complete and imperfect proteins as well as of essential amino acids was established using the capillary electrophoresis Kapel®-105M (“Lumex”, Russia). The data obtained was compared to the reference protein standard of World Health Organization/Food and Agriculture Organization (WHO/FAO, 2007).

The data on different variables, obtained from the experiment, were statistically analyzed by Statistica 10 package (StatSoft Inc.). The significance of differences between the indices was determined using the criteria of nonparametric statistics for the linked populations (differences with $P < 0.05$ were considered significant: ***$P < 0.001$; **$P < 0.01$; *$P < 0.05$; ns = not significant at $P > 0.05$). Student's t-test and Wilcoxon test were applied for the statistical analysis. Regression and Correlation analyses were also computed to establish relationships among various parameters.

The water retention capacity (WRC) was determined by the classical method of Grau and Hamm.

The thermal weight loss (TWL) was expressed as a percentage of the difference between initial weight and after cooking of samples.

The culinary-technological properties (CTP) meat was expressed by the ratio of the storage capacity of the water (WRC) to heat weight loss (TWL).

The amino-acid score (AAS) was calculated as follows:

$$AAS, \% = \frac{\text{Evaluated protein amino acid content (g/100g protein)}}{\text{FAO scoring model amino acid content (g/100g protein)}} \cdot 100$$

(1)

The coefficient of amino-acid score difference (CAAS) was estimated according to Nikitina et al. by the following formula:

$$CAAS, \% = \frac{\sum (C_i - C_{\text{min}})}{n}$$

(2)

where $C_i$ is the excess of amino-acid score, %; $C_{\text{min}}$ is the minimum score of essential amino acids of evaluated protein relative to the physiological norm (FAO scoring model amino acid content), %; $n$ is the number of essential amino acids.

The biological value (BV) was calculated by the following formula (3):

$$BV, \% = 100 - CAAS$$

(3)

MS Office 2010 package was employed for graphical presentation of the data [7].

Animal care and experimental studies were performed in accordance with the instructions and recommendations of Russian Regulations, 1987 (Order No. 755 on 08/12/1977 the USSR Ministry of Health) and "The Guide for Care and Use of Laboratory Animals (National Academy Press Washington, DC 1996). Efforts have been made in the studies to minimize animal suffering and reduce the number of samples used.

3. Results and discussion

Analysis of the results of the morphological composition of the carcasses of the experimental animals showed that the carcass weight of the bulls of group I was 3.22% higher than that of bulls of group II and 8% higher than that of animals of group III. With bulls of groups I and II, this difference was 10.9 and 14.9 kg, respectively. The pulp yield by groups was 82.3, respectively; 81.6; 81.5; the rest came from bones and tendons.

As a result of studies of the chemical composition of meat (Table 1), namely the longest muscle of the back, it was found that the dry matter was higher in animals of group I in comparison with animals
from other groups by 0.29 and 0.8%, and there was also more protein by 0.53 and 0.8%, respectively. However, fat, on the contrary, was higher in animals of the II and III experimental groups. In terms of water-holding capacity and digestibility of meat, the animals belonging to the Reflection Sovering line had advantages. Thus, the belonging of bulls to one or another line affects the chemical composition of the longissimus dorsi, which directly affects the culinary and technological properties of meat.

Table 1. Chemical composition and culinary and technological properties of the long muscle of the backs of experimental bulls.

| Indices             | I group | II group | III group |
|---------------------|---------|----------|-----------|
|                     | Mean    | Standard error of mean | P | Mean    | Standard error of mean | P | Mean    | Standard error of mean | P |
| Dry matter, %       | 24.65   | 0.52     | ns        | 24.39    | 0.44     | ns        | 23.85    | 0.40     | ns        |
| Protein, %          | 18.54   | 0.34     | ns        | 18.01    | 0.29     | ns        | 17.74    | 0.18     | ns        |
| Fat, %              | 5.04    | 0.06     | ns        | 5.34     | 0.02     | **        | 5.12     | 0.03     | **        |
| WRC, %              | 67.09   | 1.21     | ns        | 66.44    | 1.71     | ns        | 65.67    | 0.87     | ns        |
| TWL, %              | 32.64   | 0.15     | *         | 34.98    | 0.24     | **        | 35.12    | 0.33     | **        |
| CTP                 | 2.05    |          |           | 1.89     |          |           | 1.86     |          |           |

Analysis of the results of studies of the amino acid composition of the longest muscle of the back of experimental bulls, namely the essential amino acids, showed high indicators and compared with the recommended values of FAO/WHO, one can argue about the balance of muscle tissue of all experimental animals and their complete digestibility by the body (Table 2).

Table 2. The content of essential amino acids in the long muscle of the bulls of the Holstein breed of different linear affiliation.

| Amino acid               | Reference standard of FAO/WHO | I group | II group | III group |
|--------------------------|-------------------------------|---------|----------|-----------|
|                          | Mean                          | Standard error of mean | P | Mean    | Standard error of mean | P | Mean    | Standard error of mean | P |
| Valine                   | 50                            | 51.18   | 0.09     | ns        | 51.02    | 0.05     | *         | 52.66    | 0.11     | *         |
| Lysine                   | 55                            | 55.66   | 0.13     | *         | 55.18    | 0.08     | ns        | 55.11    | 0.09     | ns        |
| Leucine                  | 70                            | 71.22   | 0.12     | *         | 70.58    | 0.09     | **        | 70.87    | 0.16     | *         |
| Isoleucine               | 40                            | 40.45   | 0.05     | *         | 40.21    | 0.07     | ns        | 40.16    | 0.04     | **        |
| Phenylalanine + tyrosine | 60                            | 60.25   | 0.13     | ns        | 60.29    | 0.11     | ns        | 63.94    | 0.14     | *         |
| Methionine + cystine     | 35                            | 36.14   | 0.08     | *         | 37.16    | 0.11     | ns        | 35.77    | 0.09     | **        |
| Tryptophane              | 20                            | 31.26   | 0.09     | ns        | 31.14    | 0.10     | *         | 30.69    | 0.11     | *         |
| Threonine                | 40                            | 40.21   | 0.14     | *         | 41.15    | 0.12     | ns        | 40.01    | 0.12     | *         |

However, it should be noted about the intergroup differences in the content of essential amino acids. Thus, the amino acid valine, which is necessary for tissue metabolism and maintenance of optimal nitrogen metabolism in the body, together with leucine and isoleucine, serves as a source of energy in muscle cells, and also prevents a decrease in serotonin levels. In our study, a comparative analysis showed that there was more valine in group III compared with peers in groups I and II by 2.81
and 3.11%, phenylalanine + tyrosine by 5.77 and 5.71%, and leucine and isoleucine, on the contrary, contained less by 0.49 and 0.41%, 0.72 and 0.12%, respectively.

The amino acid lysine is necessary for the development of the body, increases the regenerative properties of bone tissues and promotes growth, its higher content was found in group I, the difference in comparison with groups II and III was 0.9 and 0.49%, as well as for the essential amino acid tryptophan 0.38 and 1.86%, respectively, the latter plays an important role in metabolism, and directly affects the toughness of meat.

As for methionine + cystine and threonine, which are responsible for the activation of lipids, proteins, carbohydrates involved in the accelerated assimilation of other amino acids, the advantage was in group II.

The biological value of meat depends mainly on the content and ratio of its constituent essential amino acids [8]. Analysis of the amino acid score showed that no limiting amino acids were found in the meat proteins of the studied groups (Figure 1).

To determine the biological value of meat, we calculated the coefficient of difference of amino acid score (CAAS), which shows the average amount of excess amino acid score of essential amino acids compared to the lowest score of any essential amino (Table 3).

It was found that a high average value of the amino acid score of the protein of the longest muscle of the back was in animals of group III, respectively, and a higher increase in the coefficient of difference in amino acid score, in comparison with groups I and II was 3.60 and 0.58%, 3.57 and 0.69%.

However, calculations of the biological value showed that bulls from group I had a more balanced ratio of essential amino acids. It is clearly seen that a significant increase in one of the amino acids led to a decrease in the biological value, in group II due to methionine + cystine and threonine, in group III - valine and phenalalanine + tyrosine.
Table 3. Biological value of proteins of the longest muscle of the back of Holstein gobies of different linearity.

| Amino acid                        | I group          | II group        | III group       |
|-----------------------------------|------------------|-----------------|-----------------|
|                                   | Mean             | Standard error  | P               | Mean             | Standard error  | P               | Mean             | Standard error  | P               |
| Valine                            | 2.4              | 0.16            | ns              | 2.0              | 0.13            | *               | 5.3              | 0.19            | ns              |
| Lysine                            | 1.2              | 0.09            | ***             | 0.3              | 0.01            | **              | 0.2              | 0.04            | **              |
| Leucine                           | 1.7              | 0.09            | **              | 0.8              | 0.07            | ***             | 1.2              | 0.21            | *               |
| Isoleucine                        | 1.1              | 0.06            | ns              | 0.5              | 0.01            | ns              | 0.4              | 0.01            | ns              |
| Phenylyalanine + tyrosine          | 0.4              | 0.07            | ns              | 0.5              | 0.08            | **              | 6.6              | 0.14            | **              |
| Methionine + cystine              | 3.3              | 0.10            | ***             | 6.2              | 0.24            | *               | 2.2              | 0.18            | **              |
| Tryptophane                       | 56.3             | 1.01            | ns              | 55.7             | 1.14            | ns              | 53.5             | 0.88            | ns              |
| Threonine                         | 0.5              | 0.06            | ***             | 2.9              | 0.11            | *               | 0.0              | 0.10            | ***             |
| Difference of amino acid score    | 66.9             | 1.12            | ns              | 69.0             | 1.16            | ns              | 69.4             | 1.15            | ns              |
| CAAS                              | 8.37             | 0.13            | ns              | 8.62             | 0.29            | ns              | 8.68             | 0.19            | ns              |
| Biological value                  | 91.63            | 1.45            | ns              | 91.38            | 1.59            | ns              | 91.32            | 1.65            | ns              |

4. Conclusion
Thus, the results of the studies carried out showed high indicators of the food and biological value of meat of the studied groups, it can be described as a full-fledged chemical and balanced according to the composition of essential amino acids. In our study, differences in the quality characteristics of meat are established depending on the linear affiliation of the bulls. It has been proven that for an additional source of receiving beef can be used on the fattening of Holstein breed bulls.

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