Original Article

# Meat Productivity, Biochemical And Amino Acid Composition Of Bull Meat With Different Genotypes

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**Doi:** 10.47750/pnr.2022.13.S05.426

## Abstract

**Purpose** of this article is based on the meat productivity index, biochemical and amino acid composition of bull meat with different genotypes in a comparative aspect. Obtained data evidence some differences in the biochemical and amino acid composition of meat in experimental animals. Thus, solids content, comprising proteins, carbohydrates, fats, minerals, hormones and vitamins were 0.5% higher in the Kyrgyz meat type and 0.5% lower in the Ala-Tau breed compared to the Kyrgyz aboriginal population, where the Aulieatin breed had the same indicators as the aboriginal one. The moisture content varies from 64.4 to 68.6%, where the largest amount of it was in the meat-mince bulls of the Aulieatin group. The amount of dry substance ranged from 31.4 to 35.6 % with a high content in individuals of the Ala-Tau breed. **Research materials and methods:** amino acids are the most important organic compounds that make up protein molecules. The studied materials on the amino acid composition of beef is the most complete in food and biological relation. Among indispensable amino acids, there are particularly important ones that are called critical, such as lysine and others. In our studies, the lysine content was highest in the Ala-Tau breed were 3223, then in the Kyrgyz meat type were 2573, in the Aulieatin breed were 2557 and in the aboriginal cattle 2486, and the average for breeds were 2710 g/100 g of meat. The standard deviations, respectively, were: 0.416; 0.270; 0.161; 0.099 and at average 0.236 g/100 g of meat. Thus, the amount of lysine in meat of all the studied breeds of cattle was in the same content, except the Ala-Tau breed cattle. **Output:** based on the studied materials on meat productivity, determination of meat biochemical and amino acid composition, cattle breed standards in the market conditions of farm household in Kyrgyzstan are developed.

**Keywords:** Breed; population; cattle; meat productivity; biochemical composition of meat; amino acids

## INTRODUCTION

The effectiveness of cattle breeding entirely depends upon increasing the meat productivity of livestock, and the last one is determined by heredity and conditions of feeding and keeping of animals. Beef breeding was and remains as the most important branch of national economy in providing the population with biologically complete food [Anisimova and Gosteva, 2014]. Meat productivity of bulls is one of the main breeding characteristics, the value of which depends on both genetic and paratypic factors.

The biochemical composition of meat and the level of meat productivity of bulls depend on many factors: breed, origin, individual characteristics of animals, their age and physiological condition, feeding and maintenance, year season, etc. [Blagov and Bykovchenko, 1981; Abdurasulov *et al*, 2017].

The biological full-value of meat protein depends on the content of amino acids and their structure. Indispensable amino acids, which are not synthesized in the human body, but come with food have a particular importance [Gosteva *et al*, 2018; Gosteva and Kozlova, 2018]. Biochemical composition of milk of different breeds cattle was researched using modern software and hardware [Zhumakanov and Abdurasulov, 2018].

The importance of minimizing the losses of genetic variants and preserving the diversity of existing local and regional groups, breeds and types of animals, including cattle, who can live in any conditions and to give products, is confirmed by the international convention on biological diversity [Vsiakikh, 1968; Blagov and Bykovchenko, 1981; Abdurasulov *et al*, 2017; Zhumakanov *et al*, 2016].

The greatest contribution to the overall genetic progress of the population is made by bull fathers and cow fathers (up to 70 to 75%). The contribution of bull mothers is also quite high and depends on the intensity of bull use [Pustotina and Pustotina, 2016].

## EXPERIMENTAL

The study was conducted on four breeds and types of cattle, ranched in the conditions of farm households in the Kyrgyz Republic. Productivity of cattle of different breeds with the study of some phenotypic properties, especially based on the productivity, such as meat productivity, the biochemical composition of meat. During the experiment, four groups of cows were selected with a total of 12 heads, one and a half years old.

The biochemical composition of milk was studied using the method of G.S. Inikhov [Inikhov, 1986], in the laboratory of chemical analysis of feed and livestock products of the Kyrgyz Research Institute of livestock and pastures.

Determination of amino acids in meat was performed by HPLC using an Agilent 1200 liquid chromatograph (USA) with diode-matrix detection at a wavelength of 280 nm. Chromatographic separation was performed on column C18 at the temperature of the column thermostat of 16˚C. As the mobile phase, acetonitrile and acetate buffer were used at pH 6.0 in the gradient elution mode with an eluent flow rate of 1.0 ml/min. Qualitative and quantitative analysis was performed in accordance with the retention time and the method of the internal standard, respectively. Standard samples of the following amino acids were used: aspartic acid, glutamic acid, serine, histidine, glycine, threonine, arginine, alanine, proline, tyrosine, valine, methionine, isoleucine, leucine, tryptophan, phenylalanine, ornithine, lysine (Merck, Darmstadt, Germany). All digital materials were processed by variation statistics method by Plokhinskiy N.A. and Merkurieva E.K. using modern software and hardware [Plokhinskiy, 1969].

## RESULTS AND DISCUSSION

Meat productivity of animals is determined by morphological and physiological features. These features are formed and developed under the influence of heredity, feeding conditions and keeping of animals during their rearing.

A more complete description of meat productivity and its formation features can be made by the quantity and quality of meat products obtained during animal slaughter. Therefore, in order to study the meat productivity of young stocks of different genotypes of cattle in accordance with the existing technology in the meat industry. The first group of animals included clean-bred Alatau bulls at the age of 18 months, the second group is clean-bred peers of Aulieatin breed, the third group is local Kyrgyz (aboriginal) breed and the fourth group is Kyrgyz meat type.

Control slaughter showed fatness of animals of all groups of the highest category, and the carcasses obtained during slaughter characterized by high quality and were assigned to the first category.

Carcasses of the Kyrgyz meat type and clean-bred Alatau bulls marked by the greatest development of subcutaneous fat tissue, and on the carcasses of the other two breeds, this feature was less developed.

**Table 1.** The results of bull's slaughter (p=12).

| Indicators | Breeds | | | |
|---|---|---|---|---|
| | Alatau | Aulieatin | Local Kyrgyz | Kyrgyz meat type |
| Live weight before slaughter, kg | 413.2 | 402.3 | 364.7 | 441.4 |
| Hot carcass weight, kg | 209.3 | 191.2 | 167.2 | 253.3 |
| Interior fat, kg | 2.03 | 1.87 | 1.91 | 2.88 |
| Slaughter-weight, kg | 211.33 | 193.07 | 169.11 | 254.18 |
| Carcass yield, % | 50.65 | 47.53 | 45.84 | 57.38 |
| Slaughter yield, % | 51.14 | 47.99 | 46.37 | 58.04 |

Kyrgyz meat-type bulls by pre-slaughter live weight (Table 1) outperformed Alatau peers on 28.2 kg, Aulieatin on 39.1 kg and local Kyrgyz on 76.5 kg.

By weight of the hot carcass, the superiority of the Kyrgyz meat type over clean-bred Alatau bulls was 44 kg and, respectively, of the two breeds 62.1; 86.1 kg. Meat-type bulls also had slaughter yield, where this indicator was 58.04%, the lowest was in local Kyrgyz cattle of 46.37% or the difference was 11.67%.

According to Nikonova E.A., Kosilova V.I. and others in the period from 6 to 9 months, the young stock of Simmental breed and crossbreeds outperformed peers of the Kazakh white-headed breed in gross weight gain in all age periods, and for the entire period of raising from 6 to 16 months up to 27.3 kg (11.7%, $P<0.05$) and 38.4 kg (16.4%, $P<0.001$). There were found inter-group differences in the level of indicators that characterize the slaughter quality of young animals [Pustotina and Pustotina, 2016].

The main property of beef is the content of a native protein in it, which contributes to the saturation of human body cells with oxygen. Biochemical composition and caloric content of beef meat should also be studied for comparison with the genetic characteristics of animals of various breeds of cattle.

Meat and meat products are one of the main sources of nutrition. The taste of meat and its nutritional value depend on such indicators as tenderness, juiciness, as well as the presence and quality of intramuscular fat deposits that create its marbling. At the same time, the nutritional value, taste and energy value of meat largely depend on its chemical composition. The study of meat chemical composition gives an opportunity to get an idea about meat and meat products quality, their nutritional value, depending on the quantitative ratio of protein, fat, minerals and water.

Thus, one of the multiple assessment methods that give the most complete characteristic of meat is the analysis of its chemical composition.

Meat quality is influenced by many factors, but the most important is the breed. Gosteva E.R. and others (2017) report that crossbred animals had a predominant mass of the front parts of the carcass as neck and shoulder, then while the mass of the hip part was inferior to that of Simmental bulls. In the average sample of meat of crossbred bulls, the moisture content was higher by 0.54%, ash by 0.1%, and protein by 0.64% less in comparison with products obtained from clean-bred Simmental animals. Simmental bulls and crossbred peers had equal values in terms of fat content. The protein-quality index in crossbred bulls was 4.82 against 5.30 or by 0.48 units less than in clean-bred peers of the Simmental breed [Abdurasulov *et al,* 2017; Zhumakanov *et al,* 2016; Gosteva *et al,* 2017].

The data obtained by us on the evaluation of control samples of meat-mince showed that the ratio of moisture and dry substances in the meat of experimental bulls of all breed groups was good. The amount of moisture ranged from 64.4 to 68.6%, where the largest amount of it was in the meat-mince bulls of the Aulieatin group. The amount of dry substance was in the range from 31.4 to 35.6 % with a high content in individuals of the Alatau breed.

According to the moisture ratio and fat in the average sample of meat-mince, the degree of maturity of the meat is judged. The obtained data show that the bulls of different breed groups distinguished by more mature meat than their peers from the Aulieatin group.

Indicators of the biochemical composition of meat make it possible to judge not only the mass fraction of dry moisture in dry substance, protein, fat and other components, but also to determine the ratio of nutrients that ultimately determine the quality of meat products.

An important indicator that characterizes the quality of meat is the caloric content. In our studies, the meat of the studied bull breeds ranged from 188.5 to 38.4 calories or 789.1 to 994.6 joules (Table 2). The highest quality was in the Alatau breed, the lowest one in the Aulieatin breed, the Kyrgyz aboriginal population was an intermediate position.

**Table 2.** Biochemical composition and calorific value of beef.

| **Breeds** | | **Alatau** | | | **Aulieatin** | | | **Kyrgyz aborogonal** | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **M** | **±** | **δ** | **M** | **±** | **δ** | **M** | **±** | **δ** |
| Moisture | % | 64.4 | 4.39 | 0.159 | 6.86 | 0.86 | 0.031 | 67.7 | 0.43 | 0.016 |
| Dry substance | % | 35.6 | 4.39 | 0.159 | 31.4 | 0.86 | 0.031 | 32.3 | 0.43 | 0.016 |
| In 100 g of absolutely dry substance, % | Ash | 3.2 | 0.42 | 0.015 | 3.8 | 0.17 | 0.006 | 2.8 | 0.14 | 0.005 |
| | Fat | 46.5 | 5.98 | 0.216 | 39.7 | 2.01 | 0.073 | 46.6 | 1.08 | 0.039 |
| | Protein | 47.9 | 8.89 | 0.322 | 56.6 | 2.04 | 0.074 | 50.5 | 1.20 | 0.043 |
| | Calcium g/kg | 2.1 | 0.08 | 0.003 | 2.3 | 0.22 | 0.008 | 2.0 | 0.55 | 0.020 |
| | Phosphorus g/kg | 1.1 | 0.13 | 0.005 | 1.0 | 0.08 | 0.003 | 0.9 | 0.04 | 0.001 |
| At natural humidity in 100 g of meat contains, g | Ash | 1.2 | 0.28 | 0.010 | 1.2 | 0.05 | 0.002 | 0.9 | 0.05 | 0.002 |
| | Fat | 14,5 | 2.99 | 0.108 | 12.5 | 0.94 | 0.034 | 15.1 | 0.56 | 0.020 |
| | Protein | 16.7 | 1.13 | 0.041 | 72.0 | 76.96 | 2.786 | 16.3 | 0.17 | 0.006 |
| | Calcium g/kg | 0.8 | 0.11 | 0.004 | 0.7 | 0.09 | 0.003 | 0.6 | 0.17 | 0.006 |
| | Phosphorus g/kg | 0.4 | 0.09 | 0.003 | 0.3 | 0.03 | 0.001 | 0.3 | 0.02 | 0.001 |
| Calorific value | Calorie | 238.4 | 45.00 | 1.629 | 188.5 | 8.19 | 0.297 | 210.6 | 4.69 | 0.170 |
| | Joule | 994.6 | 192.45 | 6.967 | 789.1 | 34.32 | 1.243 | 881.6 | 19.68 | 0.712 |

The biological value of meat is determined by the amino acid composition of protein. Amino acids are the most important organic compounds that make up protein molecules. Amino acids are the building blocks of proteins. All protein elements of a living organism are formed from amino acids. Amino acids make up all the organs of the human and animal bodies, all the muscles and ligaments, all the fluids, hormones and enzymes. Amino acids are also necessary for the formation of bones, nails, and hair. The developing body needs amino acids for full growth and development, and the adult for maintaining the vital functions of already formed organs, their renewal and regeneration, for the production of blood, lymph, hormones and enzymes. In addition, amino acids form substances responsible for innervation, that is, for the transmission of nerve impulses from the brain to organs and tissues, and back. Without amino acids, micro, macronutrients, and vitamins are not properly absorbed. Without amino acids, the body's life would be impossible.

In the process of metabolism, many amino acids are synthesized in the body from other amino acids or compounds, and therefore they are called dispensable. Amino acids that are not synthesized in the body or are formed in insufficient quantities are called indispensable. According to the content and ratio of indispensable, amino acids, feed proteins are classified into complete and incomplete. Indispensable amino acids in proteins of animal origin are more than in plant. The following amino acids are considered indispensable: arginine, caline, histidine, isoleucine, leucine, lysine, methionine, threonine, tryptophan and phenylalanine. The particularly important indispensable amino acids are called critical. These are lysine, methionine+cystine, threonine and tryptophan. The lack, absence or imbalance of indispensable

amino acids in the diets of animals is accompanied by a deterioration in the use of protein, metabolic disorders, and reduced productivity.

Lysine contains 19% of nitrogen. It is necessary for the regulation of nitrogen, calcium and carbohydrate metabolism, the synthesis of important proteins nucleotides and chromoproteins. Lysine affects the formation of red blood cells, promotes the absorption of calcium, accelerates the growth and development of young animals, and maintains a high level of milk productivity in females. In case of lysine deficiency, appetite worsens, which leads to loss of body weight and productivity of animals; bone calcification is disrupted; anemia develops. In our studies, the highest lysine content was in the Alatau breed, about 3223, then the Kyrgyz meat type about 2573, Aulieatin breed about 2557 and aboriginal cattle about 2486, and at average for breeds 2710 g/100 g of meat. The standard deviations, respectively, were: 0.416; 0.270; 0.161; 0.099 and at average 0.236 g/100 g of meat (Table 3). Thus, the amount of lysine in the meat of all the studied breeds of cattle was in the same content, except the Alatau breed of cattle.

**Table 3.** Amino acid composition of bull meat of different genotypes.

| No. | Amino acid | Breeds | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Alatau | | Aulieatin | | Kyrgyz meat type | | Kyrgyz aboriginal | | At average | |
| | | g/ 100g meat | Standard dev | g/ 100g meat | Standard dev | g/ 100g meat | Standard dev | g/ 100g meat | Standard dev | g/ 100g meat | Standard dev |
| **Dispensable amino acids** | | | | | | | | | | | |
| 1 | Asparagine | 2.408 | 0.179 | 2.005 | 0.124 | 1.962 | 0.403 | 2.005 | 0.124 | 2.095 | 0.207 |
| 2 | Glutamine | 4.103 | 0.332 | 3.418 | 0.231 | 3.188 | 0.817 | 3.418 | 0.231 | 3.532 | 0.403 |
| 3 | Serine | 1.111 | 0.056 | 1.014 | 0.095 | 0.822 | 0.223 | 1.014 | 0.095 | 0.990 | 0.117 |
| 4 | Ornithine | 0.056 | 0.036 | 0.035 | 0.006 | 0.039 | 0.011 | 0.033 | 0.004 | 0.041 | 0.014 |
| 5 | Cistein | 0.181 | 0.034 | 0.163 | 0.023 | 0.160 | 0.049 | 0.177 | 0.011 | 0.170 | 0.029 |
| 6 | Glycine | 1.224 | 0.158 | 1.010 | 0.097 | 1.068 | 0.092 | 0.955 | 0.083 | 1.064 | 0.107 |
| 7 | Arginine | 1.843 | 0.148 | 1.559 | 0.083 | 1.559 | 0.083 | 1.524 | 0.065 | 1.621 | 0.095 |
| 8 | Alanine | 1.599 | 0.111 | 1.307 | 0.081 | 1.307 | 0.079 | 1.313 | 0.092 | 1.381 | 0.091 |
| 9 | Proline | 0.365 | 0.367 | 0.326 | 0.101 | 0.326 | 0.101 | 0.334 | 0.245 | 0.337 | 0.203 |
| 10 | Tyrosine | 1.112 | 0.100 | 0.915 | 0.082 | 0.915 | 0.082 | 0.854 | 0.026 | 0.949 | 0.072 |
| **Indispensable amino acids** | | | | | | | | | | | |
| 1 | Valine | 3.813 | 0.516 | 3.305 | 1.081 | 2.692 | 0.281 | 2.921 | 0.424 | 3.182 | 0.575 |
| 2 | Methionine | 0.836 | 0.085 | 0.633 | 0,128 | 0.816 | 0.068 | 0.638 | 0.060 | 0.731 | 0.085 |
| 3 | Histidine | 1.041 | 0.093 | 0.843 | 0,064 | 0.875 | 0.049 | 0.800 | 0.037 | 0.890 | 0.061 |
| 4 | Isoleucine | 1.306 | 0.172 | 1.027 | 0,069 | 1.076 | 0.163 | 1.013 | 0.051 | 1.105 | 0.114 |
| 5 | Leucine | 2.258 | 0.225 | 1.863 | 0.119 | 1.910 | 0.186 | 1.821 | 0.068 | 1.963 | 0.149 |
| 6 | Tryptophan | 0.044 | 0.041 | 0.032 | 0.011 | 0.039 | 0.022 | 0.029 | 0.008 | 0.036 | 0.021 |
| 7 | Phenylalanine | 1.177 | 0.199 | 0.938 | 0.059 | 0.969 | 0.092 | 0.923 | 0.034 | 1.002 | 0.096 |
| 8 | Threonine | 1.205 | 0.101 | 0.997 | 0.061 | 0.970 | 0.184 | 0.974 | 0.057 | 1.036 | 0.101 |
| 9 | Lysine | 3.223 | 0.416 | 2.557 | 0.161 | 2.573 | 0.270 | 2.486 | 0.099 | 2.710 | 0.236 |

Methionine is a sulphur containing amino acid. Methionine takes an active part in protein, carbohydrate and fat metabolism, oxidation-reduction processes in the body, and is necessary for the synthesis of hemoglobin. Methionine metabolism is closely related to choline and cysteine. In our studies, amount of methionine was from 0.633 g in Aulieatin cattle and up to 0.836 g/100 g of meat in Alatau cattle.

The next amino acids belong to the critical amino acids group. The critical amino acid is Threonine, which contains 12% of nitrogen, it is part of many feed proteins, participates in leucine metabolism and carbohydrate-fat metabolism and activates the absorption of other amino acids in the diet. Threonine deficiency in diets is rarely observed, whereas corn, barley, meal pellets, meat and bone meal or fish meal provide livestock with sufficient threonine. However, diets with a predominance of wheat, beans, wheat or oat bran, dry beet pulp, skim-milk and other feeds may lack of threonine. Therewith, animals are registered a decrease in feed consumption and fatness, exhaustion, poor development of muscle tissue, and liver obesity.

In studies, this indicator ranges from 0.970 to 1.205, at average was 1.036 g/100 g of meat. Tryptophan contains 14% of nitrogen and is a precursor to nicotinic acid. Tryptophan is very important for the body, because in the process of its transformation, such important compounds are synthesized as serotonin, which has a powerful vasoconstrictor effect, nicotinic acid, etc. Tryptophan and its derivatives are participating in the regulation of endocrine status, reproductive function and lactation performance. It is necessary for the synthesis of hemoglobin and eye pigment. Tryptophan is closely related to the exchange of nicotinic acid, which helps to reduce feed consumption. This indicator was the highest 0.044 g/100 g of meat in the Alatau breed, the minimum indicator was 0.029 g/100 g of meat for the local aboriginal breed. This is due to deficiencies in the diet of blood and fishmeal, oilcake and meal pellets, which are the sources of tryptophan.

## CONCLUSION

According to obtained results on the meat productivity, the bulls of Kyrgyz meat-type have the edge over the clean-bred Alatau bulls, this is equivalent to 44 kg, Aulieatin 62.1 and aboriginal bulls 86.1 kg. Meat-type bulls also had more slaughter yield, where this indicator was 58.04%, the lowest was in local Kyrgyz cattle 46.37%, where the difference was 11.67%.

Indicators of meat biochemical composition make it possible to judge not only the mass fraction of moisture in dry substance, protein, fat and other components, but also to determine the ratio of nutrients that ultimately determine the quality of meat products. An important indicator of meat quality is the caloric content. In our studies, the meat of the studied bull breeds ranged from 188.5 to 238.4 calories or 789.1 to 94.6 joules. The highest quality was in the Alatau breed, the lowest in the Aulieatin and the Kyrgyz aboriginal population was an intermediate position.

Amino acids are of great importance for the body functioning. Some of above-studied amino acids are formed in the body, and many amino acids come from food, so it is important to determine whether an additional influx of these nutrients is necessary. Based on the available information from laboratory studies, we can conclude that it is advisable to use domestic meat supplies, regardless of breed of livestock butcher's beast, as the most complete in food and biological terms.

## ACKNOWLEDGEMENT

The authors thank Research Institute of Animal Husbandry and Pastures, Kyrgyz Turk Manas University for providing the necessary support to carry out this work.

## CONFLICT OF INTEREST

The authors declare no conflict of interests.

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