

# Effect of the level of somatotropin hormone in blood serum on the meat productivity of Aberdeen angus bulls

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**Abstract** The studies were performed on Aberdeen Angus bulls at the age of 18 months. Animals, depending on the level of somatotropin in blood serum, were divided into three groups by the percentile method: group I – up to the 25th percentile; group II – within the limits of 25-75 percentiles; group III – above the 75th percentile. The somatotropin content was determined in blood serum by enzyme-linked immunoassay using an automatic microplate analyzer Infinite F200 PRO. To study the meat qualities of steers, a control slaughter was carried out at the age of 18 months. It was found that animals with the maximum level of somatotropin in the blood serum had a higher pre-slaughter mass, hot carcass weight, chilled carcass, pulp mass and bone mass, with a minimum content of internal fat in the carcasses. The chemical composition of the average sample of meat and the longest back muscle in these animals was characterized by an increased protein content and a minimum fat concentration. The protein-qualitative indicator estimated by the ratio of tryptophan to oxyproline in the longest back muscle increased with an increase in serum somatotropin.

## 1 Introduction

Hormones are biologically active substances secreted by the endocrine glands and special groups of cells in various tissues directly into the blood. These substances play a very important role in the humoral regulation of various body functions: metabolism; appetite; mood; sleep and wakefulness cycles; temperature; pulse rate and blood pressure; sexual functions and reproduction; cell life cycles; immunity; growth and development; production of other hormones and maintenance of hormonal balance in the body [1]. One of the most studied and important hormones for cattle is growth hormone – somatotropin. Somatotropin is secreted by the anterior lobe of the pituitary gland and is considered one of the most important hormones for the formation of meat qualities of cattle [2]. Somatotropin coordinates the postnatal growth of a variety of tissues, including skeletal muscles [3]. The stimulating effect of somatotropin on growth is mediated by circulating or locally produced

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insulin-like growth factor-1 [4], which is the most important myogenic agent promoting muscle growth [5]. At the same time, metabolic disorders of somatotropin are considered as a factor of weight growth retardation in newborn calves [6].

At the same time, the amount of available information on the assessment of the effect of somatotropin on the meat productivity of steers raised for meat is limited. In this regard, the main purpose of this study was to study the meat qualities of bulls depending on the level of somatotropin in the blood serum.

## 2 Materials and methods

The studies were performed on bulls of the Aberdeen Angus breed at the age of 18 months (n=50). Animals, depending on the level of somatotropin in blood serum, were divided into three groups by the percentile method: group I – up to the 25th percentile (n=15); group II – within the limits of 25-75 percentiles (n=25); group III – above the 75th percentile (n=15). The basis for the choice of these intervals was previously conducted research [7]. The feeding and maintenance conditions for all the examined animals were identical [8].

Blood samples (9 ml) were taken from the tail vein in the morning. The blood serum was separated by centrifugation of the samples for 10 min at a speed of 1000 rpm.

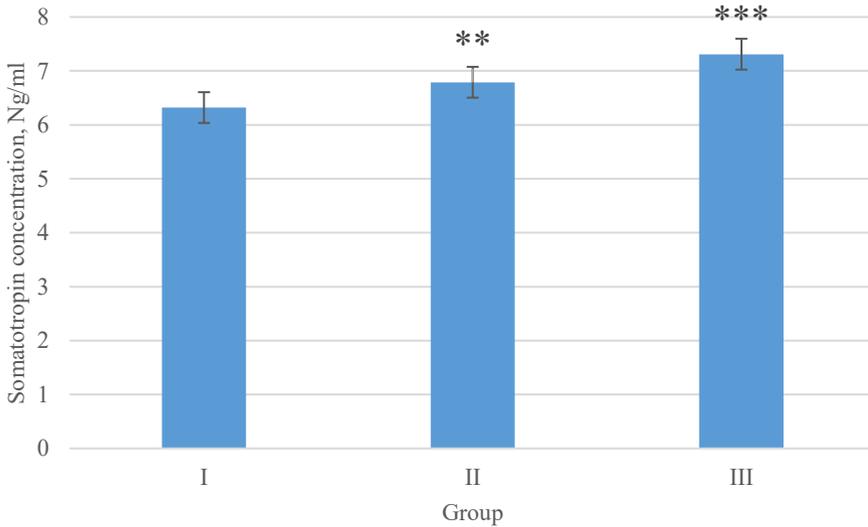
To study the meat qualities of steers, a control slaughter was carried out at the age of 18 months. At the same time, the pre-slaughter live weight, the mass and yield of the hot carcass, the mass and yield of the internal raw fat, and the slaughter mass were determined. Based on the results of deboning and venation of the half-carcass, the absolute mass and yield of the edible part (pulp), including muscle and adipose tissue, as well as the inedible part: bones, cartilage and tendons were determined. The meat index of the carcass was calculated (pulp yield per 1 kg of bones), pulp yield per 100 kg of pre-slaughter live weight, per 1 kg of inedible part of the carcass, muscle tissue yield per 1 kg of bones, per 100 kg of pre-slaughter live weight, the ratio of muscle and adipose tissue. At the same time, the mass fraction of moisture, protein and fat was determined. In the longest back muscle, the content of full-fledged proteins (according to tryptophan) and defective proteins (according to oxyproline) was additionally determined.

The somatotropin content was determined in blood serum by ELISA using an automatic microplate analyzer. The concentration of oxyproline and tryptophan in meat samples was determined by capillary electrophoresis using a drip system (Lumex-Marketing LLC, Russia; GOST 55569-2013). Laboratory studies were performed at the Center for collective use of the Federal Scientific Center for Biological Systems and Agricultural Technologies of the Russian Academy of Sciences, Orenburg, Russia.

The data obtained were subjected to statistical processing using the software package Statistica 10.0 (Stat Soft Inc., USA). The statistical significance of the differences between the groups was assessed using the Student's t-test.

## 3 Results

The actual differences between the groups of bulls in the concentration of somatotropin in the blood serum are shown in Figure 1.



**Fig. 1.** The concentration of somatotropin in the blood serum of Aberdeen Angus bulls by groups, ng/ml

The serum of group I bulls contained 6.32 ng/ml of somatotropin, which is 6.9 ( $P \leq 0.01$ ) and 13.5% ( $P \leq 0.001$ ) less than in groups II and III. At the same time, the range of somatotropin concentrations in the blood serum of group I bulls ranged from 6.11 to 6.54 ng/ml, group II from 6.58 to 6.99 ng/ml, group III from 7.12 to 7.62 ng/ml.

The results of the control slaughter of experimental bulls showed that the concentration of the hormone somatotropin had an effect on the yield of slaughter products (Table 1).

**Table 1.** Results of the control slaughter of experimental bulls of the Aberdeen Angus breed, depending on the level of somatotropin in the blood serum.

Indicators	Group		
	I	II	III
Pre-slaughter weight, kg:	505.4±4.64	517.2±4.67	525.1±4.51*
Hot carcass weight, kg	285.1±2.47	293.2±3.11	298.7±2.68**
Carcass output, %	56.41±0.321	56.68±0.340	56.88±0.284
Weight of internal fat, kg	19.27±0.223	18.92±0.194	18.18±0.263*
Internal fat output, %	3.81±0.18	3.65±0.14	3.462198±0.14
Slaughter weight, kg	304.4±2.16	312.1±2.08*	316.9±1.98**
Slaughter yield, %	60.22±0.461	60.34±0.342	60.34±0.344

Note: \* -  $P \leq 0.05$ ; \*\* -  $P \leq 0.01$

It was found that according to the pre-slaughter weight and the hot carcass weight, animals with a maximum concentration of somatotropin in blood serum (group III) exceeded individuals with a minimum by 3.9 ( $P \leq 0.05$ ) and 4.8% ( $P \leq 0.01$ ), while conceding to the accumulation of internal fat, animals with a minimum concentration of somatotropin (group I) and exceeded animals from group III increased by 5.7% ( $P \leq 0.05$ ). By slaughter weight, group I bulls were inferior to animals from groups II and III by 2.6 ( $P \leq 0.05$ ) and 4.1% ( $P \leq 0.01$ ), respectively.

It is known that as the animal's body grows, the ratio of the components that make up the edible part of the carcass changes, that is, with an increase in live weight, the slaughter yield and carcass yield increase, thereby contributing to a higher percentage of the total amount of edible meat. At the same time, the proportion of muscle tissue decreases slightly, and fat

tissue increases. In order to get an idea of the processes occurring in the carcasses of experimental bulls, it is necessary to study their morphological composition, which more characterizes their meat qualities (Table 2).

**Table 2.** Morphological composition of the carcass of experimental bulls of the Aberdeen Angus breed, depending on the level of somatotropin in the blood serum.

Indicators	Group		
	I	II	III
Weight of chilled carcass, kg	280.9±3.12	289.2±2.94	294.8±3.07**
pulp, kg	224.6±3.08	233.1±2.73*	236.7±3.31*
Pulp yield, %	79.95±0.183	80.60±0.212	80.29±0.34
Bone weight, kg	45.25±0.232	45.28±0.36	47.32±0.44**
Bone output, %	16.11±0.191	15.66±0.121	16.05±0.114
Weight of tendons and ligaments, kg	5.7±1.98	6.1±1.76	6.3±1.53
Yield of tendons and ligaments, %	2.03±0.21	2.11±0.26	2.14±0.22
Meat index	4.96±0.11	5.14±0.12	5.00±0.14
Indicator of nutritional value	4.41±0.14	4.54±0.09	4.41±0.08

Note: \* -  $P \leq 0.05$ ; \*\* -  $P \leq 0.01$

The results of the assessment of the morphological composition of carcasses showed that group III bulls were 4.9 ( $P \leq 0.01$ ), 5.4 ( $P \leq 0.05$ ) and 4.6% ( $P \leq 0.05$ ) ahead of their peers from the control group in terms of chilled carcass weight, pulp weight and bone weight, respectively.

The results of the evaluation of control samples of minced meat of experimental bulls are presented in Table 3.

**Table 3.** Chemical composition of the average meat sample of Aberdeen Angus bull calves, depending on the level of somatotropin in blood serum.

Indicators	Group		
	I	II	III
Dry matter, %	32.83±0.14	32.8±0.16	32.77±0.16
Protein, %	18.77±0.15	19.14±0.22	19.32±0.20*
Fat, %	13.08±0.18	12.68±0.16	12.44±0.2*
Ash, %	0.98±0.06	0.98±0.07	1.01±0.07
Synthesized in pulp, kg:			
protein	42.15±1.21	44.61±0.84	45.73±1.31*
fat	29.38±0.21	29.55±0.34	29.44±0.32
Energy value of 1 kg of pulp, MJ	8.31±0.23	8.22±0.15	8.16±0.11
The energy value of the entire carcass pulp, MJ	1867.5±17.5	1916.7±17.9	1931.5±18.16*
	3	4	*

Note: \* -  $P \leq 0.05$

As follows from the results obtained, in the average sample of minced meat of bulls, as the concentrations of somatotropin in the blood serum increased from the minimum (group I) to the maximum (group III), there was an increase in both the relative and actual protein content by 0.55 ( $P \leq 0.05$ ) and 8.5% ( $P \leq 0.05$ ), which was recorded against the background of a decrease in fat content by 0.64%. As for the energy value of the entire carcass pulp, it ranged from 1867.5 to 1931.5 with the highest value in animal carcasses with the maximum concentration of somatotropin in serum.

The chemical composition of the average sample of meat does not reflect the quality of muscle tissue, since the fleshy part of the carcass as a whole includes muscle, fat and connective tissues. As a result, in zootechnical practice, for a qualitative assessment of muscle tissue, it is customary to examine individual muscles, as a rule, the longest muscle of

the back. The chemical composition of the longest back muscle of experimental bulls is shown in Table 3.

**Table 4.** Chemical composition of the longest back muscle of the Aberdeen Angus bull calves, depending on the level of somatotropin in the blood serum.

Indicators	Group		
	I	II	III
Dry matter, %	24.27±0.12	24.43±0.14	24.82±0.18*
Protein, %	21.18±0.2	21.57±0.18	22.06±0.19*
Fat, %	2.11±0.14	1.87±0.12	1.74±0.16
Ash, %	0.98±0.08	0.99±0.09	1±0.06
Tryptophan, mg/%	357.4±3.87	364.5±2.98	372.3±3.11*
Oxyproline, mg/%	55.64±0.42	55.32±0.54	54.6±0.62
pH	5.6±0.14	5.6±0.09	5.45±0.08
Moisture capacity, %	54.38±0.48	54.85±0.32	55.23±0.21
Protein-quality indicator	6.42±0.12	6.58±0.09	6.82±0.14*

Note: \* -  $P \leq 0.05$

The results showed that the young animals of groups II and III exceeded the dry matter content in the longest muscle of animals of group I by 0.16 and 0.55% ( $P \leq 0.05$ ), protein – by 0.39 and 0.88% ( $P \leq 0.05$ ). According to the accumulation of fat in the longest back muscle, there were no significant differences in the section of the experimental groups.

The nutritional value of meat can be determined by the ratio of full and incomplete proteins. In this regard, in our experiment, amino acids were determined: tryptophan, which is part of complete muscle tissue proteins, and oxyproline, which forms the basis of connective tissue proteins, as well as the ratio of these amino acids (protein qualitative indicator). It was found that as the concentration of somatotropin in the blood serum increased, there was a significant increase in the amount of tryptophan in the longest back muscle by up to 4.2% ( $P \leq 0.05$ ), while the level of oxyproline tended to decrease. It is natural that the revealed dynamics affected the value of the indicator of the biological value of meat. Thus, the protein-qualitative index of the longest back muscle obtained from bulls with the maximum level of somatotropin in the blood serum was higher than the similar value calculated for bulls with minimum concentrations of somatotropin by 6.2% ( $P \leq 0.05$ ). In general, it can be stated that the protein value of bull meat in our study was at a relatively high level and depended on their fatness.

## 4 Discussion

The effect of somatotropin on the productive qualities of animals has been a subject of scientific interest for more than 80 years. Back in 1937 Asimov G.J., Krouze N.K. [9] demonstrated for the first time that injections of raw pituitary extracts from slaughtered animals increase milk production in dairy cows [10]. This discovery served as an incentive for the further development of this area of animal meat productivity. In later studies, it was found that additional administration of somatotropin contributed to an increase in carcass yield and pulp content in animal carcasses after fattening [11]. Drawing parallels with the results of our experiment, it should be noted that the bulls with the maximum concentration of somatotropin in the blood serum (group III) had increased protein levels in the longest back muscle and the average meat sample, which was recorded against the background of a decrease in fat concentration. This is due to the fact that somatotropin affects the production of hormones insulin-like growth factor and insulin, which provide an anabolic effect - increase protein synthesis in muscles, connective tissue and reduce its breakdown. In addition, growth hormone causes lipolysis and increases the availability of fatty acids for

lipid metabolism and, consequently, has the opposite effect to insulin [12]. This means that it plays an important role in peripheral metabolism and limits fat synthesis in the body [13, 14]. Subsequently, a more detailed chemical analysis showed that the additional administration of growth hormone promotes the growth of muscle mass exclusively in young animals with an identified somatotropin deficiency and does not affect the productive qualities of animals with normal hormonal status and old individuals [15]. However, this conclusion is not so unambiguous and has not been confirmed in the studies of other authors [16]. In addition, uncontrolled administration of somatotropin can be accompanied by a negative reaction of the body and cause swelling of soft tissues, allergies, as well as disorders in glucose metabolism [17].

## 5 Conclusions

Thus, the level of somatotropin in the blood serum is closely related to the indicators of meat productivity and the quality of meat of Aberdeen Angus bulls. In particular, animals with the maximum level of somatotropin in the blood serum had a higher pre-slaughter mass, hot carcass weight, chilled carcass, pulp mass and bone mass, with a minimum content of internal fat in the carcasses. The chemical composition of the average sample of meat and the longest back muscle in these animals was characterized by an increased protein content and a minimum fat concentration. The protein-qualitative indicator estimated by the ratio of tryptophan to oxyproline in the longest back muscle increased with an increase in serum somatotropin. Further development of this direction should provide for the establishment of reference ranges of somatotropin concentrations in biologically active biosubstrates, in order to develop effective technologies to improve the productive qualities of farm animals by evaluating and correcting the hormonal status.

The research was carried out with the financial support of the Russian Science Foundation under project No. 24-16-00093

## References

1. H. C. Evans, E. F. Briggs, R. H. Burnett, Z. E. Contreras-Correa, M. A. Duvic, L. M. Dysart, A. A. Gilmore, R. D. Messman, D. Reid, M. Rasit Ugur, A. Kaya, E. Memili, J Anim Sci. **100(7)**, 177 (2022)
2. J. Devesa, C. Almengló, P. Devesa, Clin Med Insights Endocrinol Diabetes **9**, 47-71 (2016)
3. J. R. Florini, D. Z. Ewton, S. A. Coolican, Endocr Rev. **17**, 481–517 (1996)
4. J. Jia, I. Ahmed, L. Liu, Y. Liu, Z. Xu, X. Duan, Q. Li, T. Dou, D. Gu, H. Rong, K. Wang, Z. Li, M. Z. Talpur, Y. Huang, S. Wang, S. Yan, H. Tong, S. Zhao, G. Zhao, M. F. W. Te Pas, Z. Su, C. Ge, PLoS One. **13(4)**, 0195378 (2018)
5. N. T. L. Anh, S. Kunhareang, M. Duangjinda, Asian-Australas J Anim Sci. **28**, 1686–1695 (2015)
6. H. M. Brown-Borg, Mol Cell Endocrinol **299**, 64–71 (2009)
7. S. Miroshnikov, O. Zavyalov, A. Frolov, I. Bolodurina, A. Skalny, V. Kalashnikov, A. Grabeklis, A. Tinkov, Biological trace element Research **180(1)**, 56-62 (2017)
8. A. P. Kalashnikov, V. I. Fisinin, V. V. Shcheglov, N. G. Pervov, N. I. Klejmenov, N. I. Strekozov, B. D. Kal'nickij, I. A. Egorov, E. A. Mahaev, V. G. Dvalishvili, V. V. Kalashnikov, V. L. Vladimirov, N. V. Gruzdev, A. T. Mysik, N. A. Balakirev, A. I. Ficev, M. P. Kirilov, V. A. Krohina, P. A. Naumenko, S. V. Vorob'eva et al., *Normy i*

*raciony kormleniya sel'skohozyajstvennyh zhivotnyh* (Izdatel'stvo «Znanie», Moskva, 2003)

9. G. J. Asimov, N. K. Krouze, J. Dairy Sci. **20**, 289 (1937)
10. R. Rezaei, Z. Wu, Y. Hou, F. W. Bazer, G. Wu, J Anim Sci Biotechnol. **7**, 20 (2016)
11. A. K. Aytac, A. K. Bilal, B. Davut, Turk. J. Vet. Anim. Sci. **39**,16–22 (2015)
12. F. J. Steyn, T. Y. Xie, L. Huang et al., J Endocrinol. **2**, 233-244 (2013)
13. R. Dumbell, J Neuroendocrinol. **34(6)**, 13133 (2022)
14. D. E. Berryman, E. O. List, Int J Mol Sci. **8**, 1621 (2017)
15. I. C. Furigo, P. D. S. Teixeira, G. O. de Souza et al., Nat Commun. **1**, 662 (2019)
16. F. Dehkhoda, C. M. M. Lee, J. Medina, A. J. Brooks, Front Endocrinol (Lausanne) **9**, 35 (2018)
17. K. Skoupá, K. Šťastný, Z. Sládek, Animals (Basel) **12(16)**, 2115 (2022)