Assessment of the influence of testosterone concentration in blood serum on meat productivity and meat quality of Aberdeen Angus bulls

A N Frolov[1*], *O A* Zavyalov[1], *T B* Aldyyarov[1], *I V* Mironova[1,2], and *I N* Sycheva[3]

[1]Federal Scientific Center for Biological Systems and Agricultural Technologies of the Russian Academy of Sciences, Orenburg, Russia
[2]Bashkir State Agrarian University, Ufa, Russia
[3]Russian State Agrarian University - Moscow Agricultural Academy named after K.A. Timiryazev, Moscow, Russia

Abstract. The studies were carried out on Aberdeen Angus bulls at the age of 18 months. The animals, depending on the level of somatotropin in the blood serum, were divided into three groups using the percentile method: group I – up to the 25th percentile; Group II – within the 25-75 percentile; Group III – above the 75th percentile. Testosterone content was determined in blood serum by enzyme immunoassay using an automatic microplate analyzer Infinite F200 PRO. To study the meat qualities of the bulls, a control slaughter was carried out. It was established that bulls with the maximum concentration of testosterone in the blood serum were superior to individuals with the minimum concentration in pre-slaughter live weight by 3.4% ($P \leq 0.05$), in fresh carcass weight by 4.7% ($P \leq 0.05$), slaughter weight – by 3.6% ($P \leq 0.01$), pulp weight – by 5.4% ($P \leq 0.05$), protein accumulation in pulp – by 8.3% ($P \leq 0.05$), dry matter content – by 0.24% ($P \leq 0.05$), protein concentration – by 0.65% ($P \leq 0.05$), protein quality indicator – by 1.3% ($P \leq 0.05$)). At the same time, they were inferior to them in weight and yield of internal fat by 12.1 ($P \leq 0.001$) and 0.6% ($P \leq 0.05$), respectively, in terms of bone content in the carcass - by 0.63% ($P \leq 0$ .05), relative fat content by 0.84% ($P \leq 0.05$).

1 Introduction

Hormones are signaling molecules that are secreted by endocrine glands to perform specific functions in cells and tissues [1-2]. Numerous studies have established the significant influence of hormones on all fundamental life processes: they determine the level of protein and DNA synthesis in cells, cell size and their mitotic activity, and therefore tissue growth, body development, sex formation, adaptation, maintenance of metabolic homeostasis, behavior and others [3]. In the body of farm animals, hormones influence metabolism by activating enzyme systems, increasing the permeability of cell membranes and accelerating

[*] Corresponding author: forleh@mail.ru

 https://doi.org/10.1051/bioconf/202412601024

synthetic processes in secretory cells. An excess or deficiency of the corresponding hormones significantly reduces the milk and meat productivity of cattle [4]. One of the important hormones for cattle is testosterone. The process of testosterone formation is under the control of the central nervous system, namely the pituitary gland [5]. Testosterone production is regulated by the so-called luteinizing hormone. Testosterone is the main male hormone responsible for the regulation of sexual differentiation, the formation of male sexual characteristics, spermatogenesis and fertility [6]. However, as the results of the studies have shown, testosterone is crucial in the implementation of the productive qualities of beef cattle [7].

At the same time, the amount of available information on assessing the effect of testosterone on the productivity of bulls raised for meat is limited. In this regard, the main goal of this study was to study the meat qualities of Aberdeen Angus bulls depending on the level of testosterone in the blood serum.

2 Materials and methods

The studies were carried out on Aberdeen Angus bulls at the age of 18 months. (n=50). Animals, depending on the level of testosterone in the blood serum, were divided into three groups using the percentile method: group I – up to the 25th percentile (n=15); Group II – within the 25-75 percentile (n=25); Group III – above the 75th percentile (n=15). The basis for the selection of these intervals was previously conducted studies [8]. Feeding and housing conditions for all examined animals were identical [9].

Blood samples (9 ml) were collected in the morning from the tail vein for three consecutive days. Blood serum was separated by centrifugation of samples for 10 min at a speed of 1000 rpm. To study the meat qualities of the bulls, a control slaughter was carried out at the age of 18 months. At the same time, pre-slaughter live weight, weight and yield of the steamed carcass, weight and yield of internal raw fat, and slaughter weight were determined. Based on the results of deboning and trimming the half-carcass, the absolute weight and yield of the edible part (pulp), including muscle and fat tissue, as well as the inedible part: bones, cartilage and tendons, were determined. By calculation, we determined the carcass meatiness index (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 fat fabrics. At the same time, the mass fraction of moisture, protein and fat was determined. In the longissimus dorsi muscle, the content of complete proteins (tryptophan) and incomplete proteins (hydroxyproline) was additionally determined.

Testosterone content was determined in blood serum by ELISA using an automatic microplate analyzer. The concentration of oxymproline and tryptophan in meat samples was determined by capillary electrophoresis using the Kapel system (Lumex-Marketing LLC, Russia; GOST 55569-2013). Laboratory studies were carried out at the collective use center of the Federal Scientific Center BST RAS, Orenburg, Russia.

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

3 Results

The actual differences between groups of bulls in serum testosterone concentrations are presented in Figure 1.

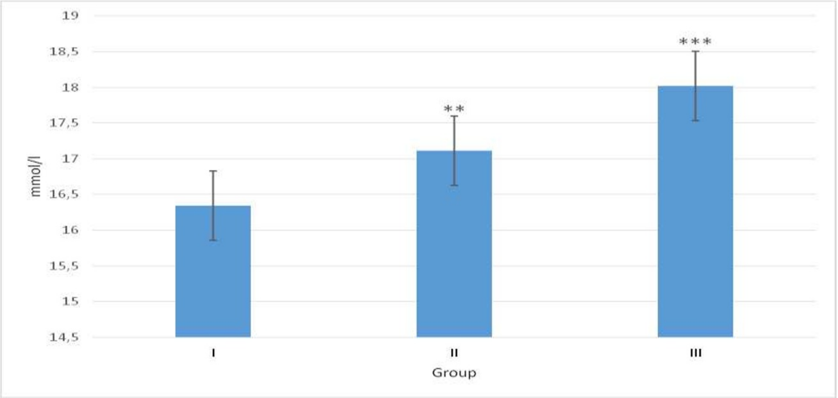

Fig. 1. Testosterone concentration in blood serum of Aberdeen Angus bulls by groups, mmol/l.

As the results of a comparative analysis showed, the serum of group I bulls contained 16.34 mmol/l testosterone, which is 4.5 ($P \le 0.01$) and 9.3% ($P \le 0.001$) less compared to groups II and III . At the same time, the range of testosterone concentrations in the blood serum of group I bulls was in the range from 15.18 to 16.55 mmol/l; Group II from 16.65 to 17.49 mmol/l; Group III from 17.63 to 19.15 mmol/l.

Results of control slaughter of experimental bulls at the age of 18 months. showed that serum testosterone levels had a significant effect on meat productivity (Table 1).

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

Indicators	Group		
	I	II	III
Weight of carcass before slaughter, kg:	507.3±4.27	515.6±4.73	524.82±4.82*
Weight of steamed carcass, kg	285.52±2.64	292.41±2.99	299.06±2.63*
Carcass yield, %	56.28±0.312	56.71±0.304	56.98±0.324
Internal fat mass, kg	20.08±0.242	18.64±0.214*	17.65±0.218***
Yield of internal fat, %	3.96±0.164	3.61±0.172	3.36±0.126*
Slaughter weight, kg	305.6±2.16	311.1±2.08	316.7±1.98**
Slaughter yield, %	60.24±0.341	60.32±0.382	60.34±0.416

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

As can be seen from the data obtained, bulls with the maximum concentration of testosterone in the blood serum were superior to individuals with the minimum concentration in pre-slaughter live weight by 3.4% ($P \le 0.05$), fresh carcass weight - by 4.7% ($P \le 0.05$), slaughter weight - by 3.6% ($P \le 0.01$), while they were inferior to them in weight and internal fat yield by 12.1 ($P \le 0.001$) and 0.6% ($P \le 0.05$), respectively.

It is known that an increase in the total mass of the carcass does not provide a complete picture of the dynamics of changes occurring in it under the influence of influencing factors. As the animal grows and develops, there is a significant change not only in the total amount of muscle, fat and bone tissue, but also in their ratios. For this reason, it is necessary to study the morphological composition of animal carcasses, which largely reflects their meat qualities. Thus, when studying the morphological composition of steer carcasses in the context of the studied groups, a general trend towards an increase in absolute and relative indicators characterizing their nutritional value was established (Table 2).

Table 2. Morphological composition of the carcass of experimental Aberdeen Angus bulls depending on the level of testosterone in the blood serum.

Indicators	Group		
	I	II	III
Weight, kg	281.8±3.01	288.1±3.08	295.2±3.03*
pulp, kg	225.4±3.01	231.4±3.06	237.6±3.06*
Pulp yield, %	80.00±0.226	80.33±0.242	80.51±0.264
Bone mass, kg	46.86±0.286	46.89±0.358	47.12±0.386
Bone yield, %	16.63±0.144	16.28±0.124	15.96±0.162*
Mass of tendons and ligaments, kg	5.94±1.672	6.04±1.72	6.12±1.87
Yield of tendons and ligaments, %	2.11±0.224	2.10±0.242	2.07±0.234
Meat index, units	4.81±0.124	4.94±0.118	5.04±0.128
Nutritional value indicator, units	4.27±0.112	4.37±0.104	4.46±0.093

Note: * - P≤0.05

Dwelling on individual aspects, it should be noted that as the concentration of testosterone in the blood serum of bulls increased from the minimum (group I) to the maximum (group III), there was an increase in pulp weight by 5.4% (P≤0.05), which was recorded at background of a decrease in the relative bone content in the carcass by up to 0.63% (P≤0.05).

Analysis of the data obtained during the experiment indicates that the composition of the average sample of minced meat taken from the carcasses of bulls of the compared groups had significant differences. More detailed results are presented in our previous study [15].

Thus, it was found that bulls with the maximum level of testosterone in the blood serum were superior to animals with minimum values of this indicator in terms of protein accumulation in the pulp by 8.3% (P≤0.05) and were inferior in relative fat content by 0.84% (P≤0.05).

When studying the chemical composition of the carcass, special attention is paid to the study of individual muscles. As a rule, in the vast majority of cases, an analysis of the longissimus dorsi muscle is performed, which most objectively reflects the qualitative characteristics of the muscle tissue of the entire carcass. The chemical composition of the longissimus dorsi muscle of Aberdeen Angus bulls, depending on the level of testosterone in the blood serum, is presented in Table 3.

Table 3. Chemical composition of the longissimus dorsi muscle of Aberdeen Angus bulls depending on the level of testosterone in the blood serum.

Indicators	Group		
	I	II	III
Dry matter,%	24.49±0.138	24.41±0.128	24.73±0.174*
Protein, %	21.32±0.186	21.64±0.199	21.97±0.184*
Fat, %	2.18±0.132	1.78±0.142	1.76±0.146
Protein, %	0.991±0.076	0.992±0.082	1.01±0.072*
Tryptophan, mg/%	4.51±3.87	4.41±2.98	4.46±3.11
Hydroxyproline, mg/%	358.8±3.38	361.9±2.94	373.4±3.65
pH	55.46±0.42	55.22±0.54	54.88±0.62
Moisture capacity, %	5.65±0.132	5.54±0.094	5.46±0.084
Protein quality indicator, units	54.46±0.296	54.82±0.354	55.18±0.358*

Note:* - P≤0.05

https://doi.org/10.1051/bioconf/202412601024

Analysis of the data obtained showed that in terms of dry matter and protein content, bulls of group III were superior to individuals from group I by 0.24% ($P \leq 0.05$) and 0.65% ($P \leq 0.05$), respectively. To get an idea of the biological value of meat obtained from bulls in our experiment, the content of amino acids was assessed: tryptophan and hydroxyproline, as well as their ratio, that is, a protein-quality indicator. As a result, it was found that despite the absence of a significant difference in the content of the above amino acids, the value of the protein quality indicator increased by 1.3% ($P \leq 0.05$) as testosterone concentrations in the blood serum increased.

4 Discussion

Our experiment established a change in meat productivity indicators, which was expressed in an increase in pulp mass and a decrease in fat yield in bulls as the concentration of testosterone in the blood serum increased. An explanation for this fact is possible taking into account previously conducted studies, which note that testosterone is a hormone that plays a key role in carbohydrate, fat and protein metabolism [10]. Testosterone is known to have a major influence on the composition of adipose tissue and muscle mass in males. Testosterone deficiency is associated with increased fat mass, decreased insulin sensitivity, impaired glucose tolerance, elevated triglycerides, and low cholesterol. The mechanisms by which testosterone acts in metabolic control pathways are not fully understood. However, as a result of studies on laboratory animals, it has been proven that testosterone at the molecular level controls the expression of important regulatory proteins involved in glycolysis, glycogen synthesis, as well as lipid and cholesterol metabolism [11]. The effects of testosterone vary in the major tissues involved in insulin action, including liver, muscle and fat, suggesting complex regulatory effects on metabolism [12]. One mechanism by which testosterone regulates fat mass is through indirect modulation of other hormones, such as increased adrenergic action [13] and growth hormone secretion, which in turn stimulates lipolysis and fat utilization [14].

5 Conclusion

Thus, it can be stated that the level of testosterone in the blood serum has a significant impact on the meat productivity of bulls, which is expressed in a significant increase in slaughter characteristics, pulp content and an increase in the biological value of meat, which is observed against the background of a decrease in the relative and absolute fat content in carcasses.

Acknowledgement

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

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