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M.I. Slozhenkina
https://orcid.org/0000-0001-9542-5893
I.F. Gorlov
https://orcid.org/0000-0002-8683-8159
O.P. Shakhbazova
https://orcid.org/0000-0001-9810-0162
R.G. Radjabov
https://orcid.org/0000-0001-8913-3501
N.V. Ivanova
https://orcid.org/0000-0002-8729-2936
D.A. Mosolova
https://orcid.org/0000-0002-5579-6726
O.A. Knyazhechenko
https://orcid.org/0000-0003-1508-2179
M. Poorghasemi
https://orcid.org/0000-0001-9199-0828
A.R. Seidavi
https://orcid.org/0000-0002-1903-2753

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Productivity of steers of different genotypes: forecast based on interior indicators

[*Produtividade de novilhos de diferentes genótipos: previsão com base em indicadores internos*]

M.I. *Slozhenkina*[1], I.F. *Gorlov*[1], O.P. *Shakhbazova*[2], R.G. *Radjabov*[2], N.V. *Ivanova*[2], D.A. *Mosolova*[1], O.A. *Knyazhechenko*[1], M.R. *Poorghasemi*[3], A.R. *Seidavi*[3*]

[1]Volga Region Research Institute of Manufacture and Processing of Meat and Milk Production - Volgograd, Russian Federation
[2]Don State Agrarian University - Persianovsky, Russian Federation
[3]Faculty of Agriculture, Rasht Branch, Islamic Azad University, Rasht, Iran

ABSTRACT

Meat productivity and quality of beef are determined by a number of factors, including pedigree traits of animals. Meat productivity is closely related to the biological patterns of their growth and development. Considering the patterns that affect meat productivity enables effective growing and fattening of livestock and obtaining commercially viable beef. To predict economically useful traits in beef cattle breeding, interior indicators can be used, as they reflect the metabolic picture of the animal's body. The research studies in physiology and biochemistry of livestock aimed at revealing the persistent mechanisms of a growing animal organism make them relevant. The article identifies a correlation between the interior indicators and the fattening indicators of three experimental groups of steers. The main forecasting factors of meat productivity indicators have been substantiated. Regression coefficients have been found and show how much the live weight varies depending on the determining factors. Meat productivity predicting procedures have been modeled with respect to the protein content in blood serum.

Keywords: live weight, beef cattle, productivity, breed, steers, genotypes

RESUMO

A produtividade e a qualidade da carne bovina são determinadas por diversos fatores, incluindo características de pedigree dos animais. A produtividade da carne tem relação íntima com os padrões biológicos de seu crescimento e desenvolvimento. A consideração dos padrões que afetam a produtividade da carne possibilita o crescimento e engorda eficazes dos rebanhos e a obtenção de carne bovina comercialmente viável. Para prever características economicamente úteis na criação de gado de corte, indicadores de interior podem ser usados, visto que refletem a imagem metabólica do corpo do animal. Tornam-se relevantes os estudos de pesquisa em fisiologia e bioquímica da pecuária com o objetivo de revelar os mecanismos persistentes de um organismo animal em crescimento. O artigo identifica uma correlação entre os indicadores internos e os indicadores de engorda de três grupos experimentais de novilhos. Os principais fatores de previsão dos indicadores de produtividade de carnes já foram comprovados. Coeficientes de regressão foram encontrados e mostram o quanto o peso vivo varia em função dos fatores determinantes. Os procedimentos de predição da produtividade da carne foram modelados em relação ao conteúdo de proteína no soro sanguíneo.

Palavras-chave: peso vivo, gado de corte, produtividade, raça, novilhos, genótipos

INTRODUCTION

One of the most relevant problems of animal husbandry in Russia is an increase in the production of meat, especially beef, as the most nutritious food product (Radjabov *et al*., 2017). Meat productivity and beef quality are determined by a number of factors, including pedigree traits of animals (Archer *et al*., 1999). Meat productivity is closely related to the biological patterns of their growth and development (Gorlov *et al*., 2019a). Considering the patterns that affect

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*Autor para correspondência (*corresponding author*)
E-mail: alirezaseidavi@iaurasht.ac.ir

meat productivity enables effective growing and fattening of livestock and obtaining commercially viable beef (KovácsnéKoncz *et al*., 2019).

Solving this problem is largely determined by effective use of genetic potential of cattle breeds (Dubovskova *et al*., 2019). Currently, highly productive breeds of both domestic and foreign origin have been expanded everywhere. Relevant is the need to study the genetic potential of their productivity. In the Southern Federal District, the Kazakh white-headed and Kalmyk breeds of beef cattle are considered promising (Abo-Ismail *et al*. 2013; Tagirov and Gizatova, 2009).

The purposes of scientific research studies were to investigate productive characteristics of young cattle of different genotypes and develop a predictive model for fattening indicators based on determining the correlation between the interior indicators of steers and their live weight. To reach the purpose, the following tasks were identified:

- to study the fattening qualities of young cattle of different genotypes;
- evaluate some interior indicators of animals of different genotypes;
- determine the direction and degree of correlation between the biochemical parameters of blood and meat productivity of young animals; and
- develop a predictive model of fattening indicators of steers of different breeds based on the correlation between the hematological and biochemical parameters and the live weight.

MATERIALS AND METHODS

The authors confirm that the studies we publish have been conducted in accordance with internationally recognized ethical standards of the Helsinki Declaration on clinical researches.

The experiment was conducted at OJSC Shurupovskoye, Frolovskyrayon, the Volgograd Region. There steers at the age of 10 months plus were examined in three analogue groups, 10 heads each. Group I included steers of the Kazakh white-headed breed, Group II included steers of the Kalmyk breed, and Group III contained their crosses between Kalmyk cows anKazakh white-headed production bulls. The experimental steers were in the same conditions of feeding and keeping, which made it possible to objectively judge the features of their productivity.

The experimental steer groups were housed separately on an unchangeable bed of straw and were free to walk in yards with mounts. The young cattle were fed with an average daily live weight gain of 1000g. The control slaughter of 18 months-old steers (3 heads from each group) was conducted at the Agro-Invest meat processing plant according to the traditional methodology.

Blood tests and biochemical analyses of meat were carried out in the complex analytical laboratory of the Volga research Institute for production and processing of meat and dairy products. Blood was taken from three steers from each group when setting and removing from the experiment from the jugular vein. The content of shaped blood elements was determined by counting them in the Goryaev chamber; hemoglobin – using a hemometer; the rate of erythrocyte sedimentation (ESR) – by the Panchenkov method; total protein in blood serum-by the refractometric method, and its fractions - by electrophoresis; calcium-by the De Waard method, phosphor-RA – by the Briggs colorimetric method.

In the course of our studies, the correlation between the morphological and biochemical blood parameters and the live weight of experimental steers of different genotypes was calculated at different age periods. The correlation between the indicators was determined by calculating the correlation coefficients, with the Student criterion applied. The linear correlation coefficients were evaluated from –1 to +1. The correlation between the parameters can be loose and close. Their criteria are graded on the Cheddock scale:

0.1 <rxy< 0.3: loose;0.3<rxy< 0.5: moderate;0.5 <rxy< 0.7: noticeable;0.7 <rxy< 0.9: close;0.9 <rxy< 1: very close.

To model and predict the productivity of steers, it is necessary to establish the nature and value of the correlation between the blood proteins of experimental 10-month-old steers and the live weight of 18-month-old steers. Given that the close correlation between the contents of erythrocytes, hemoglobin, total protein and blood albumin of 10-month-old steers (factors X) and the live weight of 18-month-old steers (effective indicator Y) was stable and significant, we could develop a model of fattening indicators by the

linear regression equation: Y = a +bX. The regression coefficient b showed the mean change in the effective indicator (in units of indicators Y) with an increase or a decrease in the value of factor X per unit.

The model of the dependence of the live weight on the morphological and biochemical blood parameters of experimental steers in Group I is represented by the following multiple regression equation: $Y = 156.12 + 2.5X_1 + 5.4X_2 + 2.11X_3 + 2.78X_4$, where X_1 is the erythrocytes, X_2 is the hemoglobin, X_3 is the total protein, and X_4 is the albumin, with a multiple correlation coefficient of R = 0.99; and standard error of 0.05; the significance of P≥0.99; and the mean approximation error of 5.5%. The regression model is considered to be well-developed and accurately describes the correlation between the indicator and the effective trait, if the average approximation error does not exceed 10%.

Modeling found a multiple regression equation for Group II steers. That is $Y = - 151.21 + 5.2X_1 + 3.9X_2 + 6.3X_3 + 3.21X_4$ with the multiple correlation coefficient R=0.99 and standard error of 0.65; the significance of P≥0.99; and the mean approximation error of 6.1%. Their dependence model of the live weight on the serum proteins is represented by the following multiple regression equation: $Y = 87.2 + 5.6X_1 + 2.84X_2 + 3.3X_3 + 1.14X_4$.

The multiple correlation coefficient R was 0.99, with a standard error of 4.4. The significance of the correlation coefficients was checked according to the Student criteria and reached P≥0.95, the mean approximation error was 6.7%. The material obtained was processed biometrically. The digital experimental data were processed by the variation method for the statistical difference between indicators compared using Student's test adopted in biology and livestock technology, with the MicrosoftExel software package being applied. The significance of the processed data is noted with corresponding designations* P<0.05; ** P <0.01; and *** P<0.001.

RESULTS

At the beginning of the experiment, 10-month-old steers in all 3 groups differed in terms of their live weight. Group III steers exceeded steers in Groups I and II by 33.1kg (11.5%, P<0.001) and 55.3kg (19.2%, P<0.001), respectively. At the end of the experiment, at the age of 18 months, all experimental steers also had different live weight (Figure 1). Group III steers exceeded their peers in Groups I and II by 15.2kg (2.9%, P<0.001) and 65.2kg (12.4%, P<0.001), respectively.

The live weight's behavior during animals' development can be controlled by their overall and average daily gains (Table 1).The data in the table show that the overall live weight gains were significantly higher by 27.9kg (11.0% (P<0.01))in Group I than in Group II and by 17.89kg (7.0% (P<0.01)) than in Group III for the entire period of fattening. The highest over all gains were recorded in Group I steers at the age of 13-14 months, in Group II steers at the age of 15-16 months, and in Group III steers at the age of 15-17 months.

Table 1. Overall and average daily live weight gains of experimental steers,kg

Age period, months	Group I Kazakh white-headed		Group II Kalmyk		Group III Cross	
	overall gain,kg	average daily gain, g	overall gain,kg	average daily gain, g	overall gain,kg	average daily gain, g
10-11	30.4±1.02	980.64±12.82	28.52±1.21	920.0±10.5	28.83±1.34	930.01±11.14
11-12	30.6±1.17	1016.99±11.34	28.29±1.01	939.99±9.52	28.5±0.45	950.0±10.63
12-13	31.9±0.96	1029.04±10.25	29.45±1.32	950.0±11.06	30.4±1.20	980.65±9.81
13-14	36.6±1.22	1180.66±9.73	30.07±1.09	969.99±12.32	31.65±1.18	1020.97±8.53
14-15	35.1±1.60	1169.99±10.82	29.4±1.72	980.01±9.34	31.5±1.34	1049.99±9.25
15-16	35.7±0.85	1151.62±12.03	31.0±1.27	1000.01±10.9	33.4±1.06	1077.42±10.83
16-17	35.1±0.97	1170.0±9.42	30.9±1.08	1030.0±10.71	33.9±1.10	1130.02±11.32
17-18	18.67±1.40	1100.0±11.63	18.57±1.20	1092.40±9.42	18.00±1.06	1058.80±8.64
10-18	254.07±0.96	1099.9±10.35	226.17±1.09	979.09±10.5	236.18±1.0	1022.4±9.89

The lowest overall gains were observed in all experimental steers aged 17-18 months. The highest values of the average daily live weight gain, characterizing the development intensity, were registered in Group I steers aged 13-14 months, in Group II steers aged 16-18 months and in Group III steers aged 16-17 months. The control slaughter results of steers at the age of 18 months showed their high meat productivity in all experimental groups (Table 2). However, steers in Groups I and III were characterized by higher slaughter grades. It was from young animals of these groups that more heavy carcasses were obtained in comparison with steers of Group II.

Table 2. Control slaughter results of experimental steers (M±m)

Indicator	Group		
	I Kazakh white-headed	II Kalmyk	III Cross
Live weight, kg	508.67 ± 5.2	458.67 ± 10.7	524.0 ± 18.7
Pre-slaughter live weight, kg	490.0 ± 5.8	440.0 ± 10.4	506.0 ± 18.1
Transportation losses, kg	18.67 ± 0.7	18.67 ± 0.3	18.0 ± 0.6
Carcass weight, kg	279.75 ± 2.9	241.98 ± 5.3	303.69 ± 12.2
Carcass yield, %	57.09 ± 0.1	55.0 ± 0.2	60.0 ± 0.3
Weight of internal fat, kg	8.97 ± 0.3	19.8 ± 0.6	17.53 ± 2.5
Internal fat yield, %	1.83 ± 0.1	4.5 ± 0.01	3.44 ± 0.4
Slaughter weight, kg	288.76 ± 2.8	261.02 ± 5.2	301.02 ± 11.1
Slaughter yield, %	58.93 ± 0.1	59.33 ± 0.3	59.49 ± 0.2
Weight of skin, kg	31.33 ± 2.2	23.67 ± 1.3	28.33 ± 1.7
Skin yield, %	6.40 ± 0.5	5.37 ± 0.2	5.60 ± 0.2
Share of internal fat in carcass, %	3.21 ± 0.1	8.74 ± 0.7	5.73 ± 0.6
Kidney suet, kg	2.93 ± 0.1	4.87 ± 0.2	87.7 ± 1.2
Kidney suet yield, %	0.60 ± 0.0	1.11 ± 0.1	1.72 ± 0.2

With respect to the carcass weight, steers in Groups I and III significantly exceeded their peers in Group II by 37.77kgor 13.5% ($P<0.05$) and 61.71kg or 20.3% ($P<0.001$), respectively. Group III steers had a higher carcass yield; crossbreeds significantly exceeded their peers of Kazakh white-headed breed by 23.94kg or 7.9% ($P<0.001$).A similar picture was observed in terms of the carcass yield, i.e., Kazakh white-headed and cross breeding steers exceeded the Kalmyk steers by 2.09 and 5.0%, respectively. According to the weight of internal fat, steers in Groups II and III had higher indices than animals in Group I by 10.83 and 8.56kg, respectively.

Hematological indicators of steers at the beginning and at the end of the experiment are shown in Table 3. The table shows that the values of some hematological parameters were within the physiological norm. The experiment found that all hematological parameters changed with age. The values of erythrocytes and hemoglobin increased slightly with age but the leukocytes content in blood had a trend to decrease with age.

The analysis of the protein composition of blood in experimental animals indicated a higher total protein content of animals in Groups I and III (Table 4). Table 4 shows that the age induced an increase in total protein in serum. During the experiment, the lowest total protein content in blood serum was registered in Group II steers at the age of 10 months (82.28+2.36 g/L). Moreover, this indicator compared in steers of different genotypes showed higher values of total protein in Group III in the initial period of fattening. The Group III steers at 10 months of age had the most intense albumin fraction synthesis of 37.82±1.08. The content of globulins that perform the function of immunobiological resistance in the body also increased with age.

Table 3. Hematological indicators of steers during experiment

Indicator	I Kazakhwhite-headed	II Kalmyk	III Cross
		10 months	
Erythrocytes, 10^{12}/L	5.98± 0.21	6.27± 0.11	6.21± 0.17
Leukocytes, 10^{9}/L	8.31± 1.16	9.49± 1.18	8.48± 1.25
Hemoglobin, g/L	116.67± 3.51	116.33± 2.95	115.00± 2.11
		18 months	
Erythrocytes, 10^{12}/L	6.64± 0.19	6.86± 0.18	6.65± 0.11
Leukocytes, 10^{9}/L	6.27± 1.14	6.80± 1.51	6.42± 1.1
Hemoglobin, g/L	124.67± 3.11	123.33± 2.91	122.00± 2.78

Table 4. Biochemical blood parameters of experimental steers

Indicator	Group I Kazakh white-headed	II Kalmyk	III Cross
	10 months		
Total protein, g/L	83.64±2.22	82.28+2.36	85.38±2.23
Albumins, g/L	36.21±1.18	35.11±1.15	37.82±1.08
Globulins, g/L	47.43±1.17	47.14±1.12	47.56±1.09
	18 months		
Total protein, g/L	84.87±2.34	83.94±2.32	86.72±2.21
Albumins, g/L	36.97±1.18	36.19±1.12	38.83±1.11
Globulins, g/L	47.90+2.15	47.75+2.11	47.89±2.01

Our studies established a positive correlation between the morphological and biochemical blood parameters and the live weight of experimental steers aged 10 months (Table 5). Our study established a high positive correlation between the productivity of steers and the content of hemoglobin and erythrocytes in their blood. The correlation coefficient (g) between the indicators such as the erythrocyte value in blood and the live weight of steers at the age of 10 months amounted to 0.59; 0.58; and 0.62. A higher correlation was registered between the hemoglobin and the productivity index. In terms of groups, the correlation coefficient between the hemoglobin content and the live weight amounted to 0.63; 0.64 and 0.71, with the correlation between the live weight and leukocytes being loose and the correlation coefficients being insignificant. At the same time, there was observed a general pattern that showed a close positive correlation between the contents of total protein and albumins and the live weight; and a loose positive correlation between the content of globulins and the live weight.

Table 5. Correlation coefficients between the morphological and biochemical blood parameters and the live weight of 10-month-old steers

Indicator	Group I	II	III
Erythrocytes,10^{12}/L	0.59	0.58	0.62
Leukocytes, 10^{9}/L	0.14	0.18	0.11
Hemoglobin, g/L	0.63	0.64	0.71
Total protein, g/L	0.66	0.55	0.57
Albumins, g/L	0.65	0.61	0.71
Globulins, g/L	0.05	0.08	0.07

Similar results were obtained in the analysis of correlation between the morphological and biochemical blood parameters and the live weight of experimental steers at the age of 18 months (Table 6).A moderate correlation was found between the contents of hemoglobin and

erythrocytes and the live weight; and a loose correlation with unreliable correlation coefficients was revealed between the live weight and the leukocytes of steers at the age of 18 months. The study also established the closes thighly significant correlation (P>0.99) between the contents of total protein and albumin and the live weight during all growth periods of young cattle. The globulin fraction of proteins was insignificantly correlated with the live weight of steers in different periods of growth (P>0.99).

Table 6. Correlation coefficients between the morphological and biochemical parameters of blood and the live weight of 18-month-old steers

Indicator	Group		
	I	II	III
Erythrocytes,10^{12}/L	0.58	0.59	0.62
Leukocytes, 10^{9}/L	0.02	0.07	0.08
Hemoglobin, g/L	0.65	0.59	0.68
Total protein, g/L	0.57	0.59	0.65
Albumins, g/L	0.63	0.74	0.69
Globulins, g/L	0.01	0.05	0.09

The correlation coefficient (g) between the erythrocytes of 10-month-old steers and the live weight of 18-month-old steers amounted to 0.47; 0.55; and 0.64 (Table 7). A higher correlation was established between the content of hemoglobin the productivity index. The correlation coefficient between the hemoglobin content and the live weight amounted to 0.53; 0.55 and 0.63; the correlation between the live weight and leukocytes was loose. The correlation coefficients between the total blood protein of 10-month-old steers and the live weight of 18-month-old steers in all the studied groups were high, i.e., 0.69, 0.62, and 0.65 (P≥0.99);a close correlation was observed with respect to albumins, i.e., 0.67, 0.57, and 0.66 (P≥0.99). There was a loose correlation between the serum globulins of experimental steers of different genotypes.

Table 7. Correlation coefficients between the morphological and biochemical blood parameters of 10-month-old steers and the live weight of 18-month-old steers

Indicator	Group		
	I	II	III
Erythrocytes,10^{12}/L	0.47	0.55	0.64
Leukocytes, 10^{9}/L	0.12	0.17	0.12
Hemoglobin, g/L	0.53	0.55	0.63
Total protein, g/L	0.69	0.62	0.65
Albumins, g/L	0.67	0.57	0.66
Globulins, g/L	0.12	0.06	0.08

The resulting pairwise linear regression coefficients (P>0.99) are presented in Table 8.The regression coefficient between the morphological blood elements of 10-month-old steers and the live weight of 18-month-old steers showed that an increase in the erythrocytes content in blood can indicate 3.82kg of the live weight gain in steers in Group I; 3.52 and 3.45kginGroups II and III, respectively. The regression coefficient between the blood proteins of 10-month-old steers and the live weight of 18-month-old steers showed that a 0.1g/L increase in the total protein content in blood indicated 3.24kg of the live weight gain of steers in Group I; 3.53 and 2.92kginGroups II and III, respectively. The analysis enabled obtaining a multiple linear regression equation for steers in all groups.

The equation was significant (P>0.99) and showed the dependence of the effective trait Y—the live weight of experimental steers at the age of 18 months—on the indices of erythrocytes, hemoglobin, total protein and serum albumins of steers at the age of 10 months. The regression model obtained can be used in predicting the productivity and selection. The erythrocytes, hemoglobin, total protein and serum albumins are also the main factors that had a significant effect on the live weight gain in Group III steers.

Table 8. Regression coefficients between the morphological and biochemical blood parameters of 10-month-old steers and the live weight of 18-month-old steers

Indicator	Regression coefficient		
	I	II	III
Erythrocytes,10^{12}/L	3.82	3.52	3.45
Leukocytes, 10^{9}/L	0.03	0.01	0.02
Hemoglobin, g/L	3.62	3.94	3.88
Total protein, g/L	3.24	3.53	2.92
Albumins, g/L	5.31	5.52	5.18
Globulins, g/L	0.02	0.07	0.09

DISCUSSION

Over the period from 10 to 18 months of age, the average daily gain of experimental steers averaged 1099.9±10.35 g in Group I, 979.09±10.50 in Group II, and 1022.4 ±9.89 g in Group III. Group I steer exceeded their peers in Group II by 120.8 g (11.0%, P<0.05) and in Group III by 77.5 g (7.0%, P<0.001). Consequently, the steers of Kazakh white-headed breed and their crosses had the highest growth intensity among the breeds studied.

The study of the growth and development characteristics of young cattle established different patterns in their live weight, overall and average daily gains with respect to the age. The differences in the growth intensity of experimental steers can be explained by the specific metabolism in crossbreed animals due to the heterosis effect and hereditary traits of the Kazakh white-headed breed (Crowley *et al*., 2011; Doyle *et al*. 2020; Gorlov *et al*., 2019b). The carcass yield of crossbreeding steers was by 2.91% higher than that of Kazakh white-headed steers. The share of internal fat in carcass was also higher by 5.53 and 2.52% in animals of Groups II and III compared to Group I.

Interior indicators are known to characterize the level of animal productivity and their natural resistance; they are also of great importance for the development of tests to assess steers' breeding and productive qualities (Gorlov *et al*., 2016a). The growth intensity of steers is driven by the corresponding metabolism activity that can be objectively assessed by a blood test (Gorlov *et al*., 2016a). The values of erythrocytes and hemoglobin increased slightly with age. This was probably due to the voltage of oxidative processes in the animal organism during the period of their maximum growth intensity (Kadarmideen, 2014). The leukocytes content in blood had a trend to decrease with age, with the superior values being registered in Kalmyk, which was explained due to their better adaptability to environmental conditions (Apaoblaza *et al*., 2020).

Increased contents of erythrocytes and hemoglobin in blood of animals indicated a high level of metabolism in their organisms, which was caused by a direct correlation between the morphological blood parameters and the live weight gain. An important component of the animal's blood is protein and its fractions. Proteins of blood plasma perform various functions. Being in close binding with proteins of various tissues, they react very subtly to physicochemical changes in animal organs. The protein metabolic imbalance in tissues has a considerable effect on the composition of blood proteins (Conroy *et al*., 2020; Gorlov *et al*., 2014).

With age, total protein concentration increased regardless of the genotype and amounted to 84.87±2.34, 83.94±2.32 and 86.72±2.21g/L by 18 months, which was higher than the initial level by 1.47; 2.01; and 1.56%. This can be explained by the change and restructuring of the functions regulating mechanisms by steroid hormones during puberty (Velmatov *et al*., 2018). By the age of 18 months compared to the previous period, there was an increase in the albumin fraction concentration by 2.09; 3.07 and 2.67%, respectively. In our opinion, the increase in serum albumin occurred due to the active mobilization of the body reserves of young cattle and provided the targets of metabolism in the context of the growth and development of animals (Roudbari *et al*., 2020).

The comparative analysis revealed lower concentrations of globulins of steers at the age of 18 months in Group II. The morphological and biochemical analysis established the physiological norm of all changes in the blood

composition. Their higher value, as a rule, was accompanied by an increase in the growth intensity of animals in certain age periods. Thus, the research results indicated good prospects of creating crossbreeds between the Kazakh white-headed and Kalmyk breeds, as these breeds have a high genetic potential for high meat productivity (Arthur *et al*., 2001).The correlation between the morphological and biochemical blood parameters and the live weight of experimental steers of different breeds at different ages had significant difference. A higher and more significant correlation coefficient between the globulins and the live weight was found in Group II steers, which may indicate the predominance of lipid metabolism over the protein one (Berry and Crowley, 2012; Gorlov*et al*., 2019a).

The analysis of the data obtained indicated a positive correlation between the live weight and the morphological indicators at different values of correlation. The study showed that the content of morphological elements and proteins in blood probably reflected the potential of steers to accumulate body weight and can be considered a criterion of the body's metabolism (Silva-Vignato *et al*., 2017; Komandzhaev *et al*., 2015). The study found that the regression coefficient between the contents of leukocytes and globulins and the live weight had lower values, and the regression coefficient between the contents of erythrocytes, hemoglobin, total protein and blood albumins and the live weight had higher values, so we can assume that their effect on the effective indicator was significant. Thus, we identified and substantiated the main parameters that had the greatest impact on meat productivity of experimental steers of different genotypes. These are erythrocytes, hemoglobin, total protein and serum albumins.

CONCLUSION

The obtained correlation between some interior traits and fattening indicators, in our opinion, makes it possible to use the identified close correlation as markers in the selection of cattle to increase the level of their meat productivity.

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