Meat productivity and interior features of the different genotypes of the rams Edilbaev breed

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Abstract. One of the key factors ensuring the increase in sheep production in future is the development of intensive reproduction of the herd. The article presents the results of an experiment that helped study and give comparative characteristics for the meat productivity and natural resistance of the pedigree Edilbay sheep breed in conditions of a pedigree reproducer in 2018-2019. The young stocks of original and new types were studied to assess their interior traits, establish the direction and degree of correlation between the biochemical blood parameters and meat productivity of young sheep, as well as determine indices reflecting the immune status of organisms of the experimental sheep. When starting the test, the live weight of animals of the pure and pedigree types were almost the same, while when finishing the experiment at the age of 12 months, animals in Group II exceeded animals in Group I by 4.3 kg (5.8%, P<0.01). The best average daily gain of experimental sheep was also in Group II, i.e., 167 g, which was higher than in Group I by 9.1% (P<0.01). Consequently, the rams of new type had the highest growth rate. The data of the control slaughter showed that both experimental groups had high meat productivity. The analysis of natural resistance indicators of small ruminants of various types and their relationship with productive qualities in different climatic zones have also shown the need to use different integral indicators to assess the immune status in further breeding of animals. The analysis of natural resistance indicators of small ruminants of various types and their relation with productive qualities in different climatic zones has suggested that there is a need to use several markers to assess the immune status for further sheep breeding.

1. Introduction

All over the world, one of the priority tasks of animal husbandry is to solve the problem of increasing food resources and providing the population with meat products according to the scientifically based nutritional standards [1]. The consumption of food products of animal origin is one of the main indicators of the life standard of the population [2-4].

Currently, much attention is paid to the development and qualitative improvement of meat-and-fat sheep farming [5-8] This is due to the ever-increasing market demand for qualitative mutton.

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World experience in the sheep husbandry shows that increasing the efficiency and competitiveness of the industry is associated with a more complete use of sheep meat productivity [9-12]. The sheep breeding profile for the lamb production requires the breeds characterized by high meat productivity and early maturity. The meat-and-fat tail breeds fully meet this requirement. The Edilbay breed is one of the most promising sheep breeds of meat-and-fat productivity [13, 14]. These sheep have a strong constitution, are well adapted to scarce feed, severe and arid natural and climatic conditions of the zone of semi-desert steppes [14].

The intra-breeding method enabled obtaining a fairly large population of highly productive sheep that differed from other populations due to their exterior-constitutional type [15]. This population was tested as a new intra-breed type.

The study of economically useful traits and biological features of the new intra-breed type in a comparison with the original Edilbay sheep is of great scientific and practical relevance.

The purpose of the work was to determine the relation between the meat productivity of young sheep of different genotypes and biochemical blood parameters, as well as develop a resistance index to increase the level of productivity and adaptive capabilities of sheep for their selection.

In accordance with the purpose, there were identified the following tasks:

- to study the fattening and slaughter parameters of young stock of pure and new types;
- evaluate the exterior traits of young stock of the pure and new types;
- determine the direction and degree of relation between the biochemical parameters of blood and meat productivity of young sheep;
- identify humoral and cellular factors that reflect the state of the body’s immune status;
- develop a resistance index using a genetic-statistical indicator.

Geopolitical instability in the global economy consists in increasing disagreements between different countries, generates not only economic conflicts, but also political and military confrontations, negatively affects the development of the national economy, and does not allow it to develop effectively. The current carries political, social, and even ideological confrontation exacerbated by sanctions against Russia is a new form of global political and economic transformation and requires a search for a new path for the economic development of the agricultural sector of the national economy, including the domestic livestock industry.

2. Materials and research 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 in two groups of 2 months rams, 10 heads each, in OOO “Volgograd-Edilbay” in the Volgograd Region. The groups were formed on the analogue principle. Group I included Edilbay rams, Group II – the new rams intrabreed type of Edilbay breed obtained through the use of induction crossing, the essence of which consists in simultaneous use of Gissar sheep breed for mating with ewes of Edilbay breed improve the individual properties of rock without any substantial modification of its basic qualities. Subsequently, the resulting offspring are re-crossed with animals of the improved breed and only the next generation is bred “in itself”, using strict selection of animals. The area the experimental sheep were kept in was located in the eastern part of the Volgograd region in the Bykovsky rayon that covers the northwestern termination of the Caspian lowland. The farm traditionally has a grazing system for keeping sheep in winter and spring. Animals were in the same conditions of feeding and keeping, which made it possible to objectively judge the features of their productivity. The experimental animals were kept in pasture, and the diet consisted mainly in summer of grasses of cereals, tychchak-wormwood and feather grass types in the territories of estuarine irrigation. In winter, when the ephemeral vegetation is still poorly developed, the sheep are fed with concentrated feed. Based on existing standards, the approximate annual rate of feed accumulation per sheep should contain 4.0 centners of hay, 14-15 centners of grazing grass and 2.0-2.1 centners of concentrated feed.
When performing the work, there were studied the following parameters:
1) the live weight of rams at 2 and 12 months of age was determined by individual weighing with an accuracy of 0.1 kg in the morning before feeding. Based on the data obtained, the overall and average daily gains in the live weight were calculated;
2) the meat productivity was studied according to the results of a control slaughter at 12 months of age in terms of the pre-slaughter live weight, weight of fresh carcass, slaughter weight and slaughter yield according to the method proposed by All-Russia Research Institute for Animal Husbandry (VIZh) (1978); and the hemoglobin content was determined according to the Sahli method; the number of leukocytes was found in the Goryaev’s chamber; erythrocytes were counted on the colour density meter; the total protein was determined by a refractometer; and protein fractions were found by electrophoresis on paper.

The natural resistance and immune status of the animal organism were evaluated in terms of the bactericidal activity of blood serum (method developed by Smirnova O.V. and Kuzmina T.A. and modified by Bukharin O.V. and Sozykina A.V. 1979), lysozyme blood activity (according to Grant), phagocytic activity, phagocytic index and phagocytic number (according to Cost and Stenko method (using the ability of white blood cells to absorb and digest microbes to assess their functional activity).

To determine the statistical weight of each breeding trait was of great importance for this index being applied. In general terms, the index represents the following equation:

\[ RI = K_1 \times X_1 + K_2 \times X_2 + \ldots + K_n \times X_n; \]

where \( K \) is the weight coefficient of a trait;
\( X \) is the value of the trait.

**Statistical analysis.** All material obtained was processed biometrically. The digital material of the experimental data was processed by the method of variation statistics with respect to the significance of differences between the indices compared using the Student criterion adopted in biology and livestock technology. The degree of reliability of the data processed was indicated by the corresponding designations: \( p < 0.05 \); \( p < 0.01 \); and \( p < 0.001 \).

3. **Results**

When starting the experiment, the live weight of sheep of the pure Edilbay and new intra type was almost the same. At the beginning of the experiment, the difference between animals was within the margin of error, while at the end of the experiment, the 12 months sheep in Group II exceeded sheep in Group I by 4.3 kg (5.8%, \( p < 0.01 \)) (figure 1).

![Figure 1. Live weight of rams (**P value < 0.01).](image)

The exterior indicators were also determined that made it possible to assess the growth, development, health, productivity and abilities of sheep to adapt to climatic and keeping conditions. To obtain the
development indices of rams, their bodies were measured; these data are presented in table 1 and figure 2.

**Figure 2. Ram of Edilbay sheep breed.**

The study enabled finding general biological development patterns of the sheep in ontogenesis. Based on the above data, the experimental Edilbay sheep were approved to be well adapted and a fairly high level of productivity was predicted.

The value of the rams’ overall live weight gain for the entire period of the experiment in Group I was 46.0 kg, and in Group II 50.1 kg. So, with respect to this indicator, the Group II rams were superior to the Group I rams by 8.9% (*p* <0.01).

The daily average gains characterizing the growth rate of the experimental sheep were also better in Group II (167 g), while in Group I it was 153 g, which was by 9.1% lower (*p* <0.01). Consequently, the sheep of the new inbreeding type had higher growth rate.

The results of the control slaughter of rams at the age of 12 months showed high meat productivity of animals in both experimental groups (table 2).

**Table 2. Slaughter indicators of Edilbay rams (n=10).**

| Traits                      | Types                  |
|-----------------------------|------------------------|
| Pre-slaughter live weight, kg | pure 74.20±0.65        |
| Weight of hot carcass, kg    | Types new intra-breed  |
| Weight of internal fat, kg   | 78.50±0.72**           |
Weight of fat tail, kg  10.2±0.12  10.4±0.14
Slaughter weight, kg  44.74±0.23  48.04±0.34**
Slaughter yield, %  60.30  61.20

In terms of the carcass weight, the sheep in Group II exceeded their peers in Group I by 3.04 kg or 9.1% with a high degree of probability (P<0.001). Similar results were obtained for the slaughter weight, i.e., the rams in Group II exceeded their peers in Group I by 3.3 kg or 7.4% with a high degree of probability (P<0.001). New intra-breed rams had slaughter yield of 61.2%, which was by 0.9% higher than their analogues had.

The blood composition of young sheep was distinguished by relative constancy, which ensured the conservation of specific, pedigree and individual characteristics of the animals. However, the composition of the blood was quite labile, which allowed using it as an important mechanism for adaptation to fluctuations in the living conditions of animals.

Interior parameters characterize the level of animal productivity and state of their natural resistance and are of great importance for developing tests to evaluate the breeding and productive qualities of animals.

The resistance is currently considered not only as a biological factor, reflecting the body's ability to withstand the adverse effects of the external environment, but also as an economically useful trait.

The characteristics of the hematological parameters allowed us to judge the resistance of the animal organism when adapting to new climatic conditions.

The hematological parameters in experimental animals under study were within the physiological norm.

Table 3. Hematological and immunobiological indicators (n=10).

| Indicators                        | Months | Types                  |                |
|----------------------------------|--------|------------------------|----------------|
|                                  |        | pure                   | new intra-breed|
| Total protein, g/l               | 4      | 62.42±0.43             | 63.48±0.43     |
|                                  | 10     | 63.3±0.51              | 65.1±0.51      |
| Hemoglobin, g/l                  | 4      | 89.74±1.23             | 90.86±1.32     |
|                                  | 10     | 93.42±0.98             | 96.6±1.14*     |
| Erythrocytes, 10^{12}/l          | 4      | 7.39±0.21              | 7.48±0.17      |
|                                  | 10     | 7.28±0.19              | 7.33±0.16      |
| White blood cells, 10^{9}/l      | 4      | 8.64±1.23              | 8.79±1.35      |
|                                  | 10     | 8.46±1.19              | 8.69±1.24      |
| Platelets, 10^{9}/l              | 4      | 253.5±6.25             | 275.4±7.68*    |
|                                  | 10     | 285.6±7.86             | 296.9±8.23     |
| Phagocytic activity, %           | 4      | 54.16±0.13             | 56.42±0.19***  |
|                                  | 10     | 56.23±0.18             | 56.89±0.18*    |
| Bactericidal activity, %         | 4      | 56.35±0.23             | 56.98±0.17*    |
|                                  | 10     | 55.69±0.15             | 56.23±0.19*    |
| Lysozyme activity, %             | 4      | 56.84±0.25             | 57.96±0.21**   |
|                                  | 10     | 57.18±0.22             | 58.24±0.16**   |

An important component of the animal’s blood is protein and its fractions. The concentration of the total protein in blood serum of the 7 months rams in Group II was 65.10 g/l, which was by 2.8% higher than in their analogues in Group I (P <0.01).

The intensity of the respiratory function of the blood is largely determined by the level of hemoglobin that is the main supplier of oxygen to tissues and organs. As can be seen from Table 3, the level of hemoglobin in blood of the experimental sheep was not the same. A higher level of hemoglobin was
registered in sheep in Group II, which indicated a more intense metabolic process compared with their peers in Group I.

The analysis showed that the highest levels of hemoglobin, red blood cells, white blood cells and platelets were registered in animals in Group II. The data obtained indicated an increased oxygen capacity of blood of these animals, as well as their better respiratory-oxidative ability, therefore, more intensive metabolic processes.

The analysis of the quantitative content of leukocytes did not reveal statistical significance between the experimental groups, and the level of their contents was within the physiological norm.

The obtained indicators of humoral defense factors in experimental animals allowed us to establish that the blood serum of rams in Group II had higher phagocytic, bactericidal and lysozyme blood activities (PhBA, BBA and LBA) compared to the rams in Group I.

The levels of the PhBA, BBA and LBA of sheep in Group II was higher by 1.2%, 1.0% and 1.8%, respectively, with a high level of statistical significance compared to their peers. This indicated a higher protective potential of the rams of a new Edilbay intra-breed. High immunological status indicated the intensity of metabolic processes in animals.

The purpose of the experimental research was to study the direction and degree of correlation between the biochemical parameters of blood and meat productivity of young sheep.

The studies showed a positive correlation between the live weight of animals at the beginning and end of fattening period with the total protein content in blood serum being 0.54-0.64 in Group I and 0.50-0.67 in Group II.

The relation between the overall live weight gain and total protein concentration was established to be positive with values of 0.65 in Group I and 0.75 in Group II; the relation between the slaughter weight and total protein in blood serum was 0.47-0.50 in Group I and 0.49-0.51 in Group II.

Therefore, if the total protein concentration in blood serum increased, so did the live weight, overall live weight gain and slaughter weight.

The data obtained in terms of the relation between some interior parameters and fattening and slaughter indices, in our opinion, make it possible to use the high correlative relations identified as markers to increase the level of meat productivity in sheep breeding.

The study of indices of the natural resistance, factors, affecting its development, their relations with productive qualities under specific climatic conditions, as well as livestock production technologies is of great scientific and practical interest.

To objectively characterize the immune status of animals, we made an effort to evaluate the state of natural resistance using a genetic-statistical indicator—the resistance index (RI). When calculating this index, humoral and cellular values, reflecting the state of the body's immune status, were used.

The weight coefficient of a trait depended on many factors and was determined by the heritability estimate, degree of variation and selection differential.

When calculating the resistance indices of sheep, we took into account 5 parameters, i.e., bactericidal activity of blood serum, lysozyme activity of blood serum, phagocytic activity of blood serum, phagocytic index and phagocytic number.

The analysis of the results showed that the sheep resistance index was at a high level. This indicator was slightly lower in animals of Group II (96.2 - 97.3) than in animals of Group I (97.1 - 98.8), although the Group II animals exceeded their peers with respect to the absolute measures of humoral and cellular defense of the body. This was probably due to the fact that the rams in Group II (a new intra-breed type) were less acclimatized to local environmental conditions than the original Edilbay sheep and required closer veterinary attention.

The analysis of natural resistance indicators of small ruminants of various types and their relation with productive qualities in different climatic zones suggested that there is a need to use several markers to assess the immune status for further sheep breeding.

Calculation of the resistance index as an integral indicator, its use and regular monitoring with respect to the interior measurements during selection in breeding farms will make it possible to obtain more
reliable information on the resistance indicators of young sheep in the early stages of ontogenesis and thereby increase the efficiency of selection according to economically useful traits.

4. Discussion

Current data characterizing the correlation between the most likely markers of resistance and productivity indicated the possibility of a simultaneous selection in terms of these traits [5, 6]. Breeding with respect to the resistance is becoming an essential element of modern animal selection programs [7].

In some studies, the results of control slaughter show that cross-bred rams were superior to purebred rams in meat qualities [10, 14]. In our research, animals of a new intra-breed type of the Edilbaev breed had high indicators of meat productivity and natural resistance. Indicators of the morphological composition of the carcass is observed that the hybrids are superior to pure-bred rams Edilbaev content of the pulp, and the fat inferior to them.

Similar results were obtained for slaughter weight: group II animals outperformed group I peers by 3.3 kg, or 7.4% with a high probability ($p<0.001$). The slaughter yield was higher in the new intra-breed type of sheep – 61.2%, which is higher than the analogs by 0.9%. The results obtained are most likely due to the effect of heterosis [15].

In terms of hematological indicators, crossbred sheep are superior to purebred ones. With age, the number of red blood cells and white blood cells in all studied animals decreases, and the content of hemoglobin and platelets increases. Phagocytic, bactericidal and lysozyme activity is higher in crossbred animals, which indicates better resistance to infections. The obtained data indicate an increased oxygen capacity of the blood of these animals and a better respiratory-oxidative ability, therefore, more intensive metabolic processes in animals of group II.

It was found that with an increase in the concentration of total protein in the blood serum, the live weight, absolute gain and slaughter weight increases [6, 8].

The obtained materials are consistent with the previously obtained data [1, 15] on the relationship of some interior indicators with feed and slaughter, in our opinion, make it possible to use the identified high correlative relationships as markers in the selection of animals to increase the level of meat productivity.

When calculating the indices of animal resistance, it was found that the animals of the new intra-breed type are slightly inferior to the original breed in this indicator, although they are superior to their peers in absolute indicators of humoral and cellular protection of the body. This is probably due to the fact that the animals of the new intra-breed type are less acclimated to local natural conditions than the original animals of the Edilbaev breed. These animals, as a rule, require closer attention from the veterinary service [13]. Therefore, when using these animals, it is necessary to improve the technology of feeding and keeping to the greatest extent possible.

5. Conclusion

Thus, the Edilbay sheep of a new intrabreed type have high meat productivity and high rates of natural resistance. Based on the obtained data, in order to improve the economic - useful properties of animals Edilbaevskoy year-round grazing is recommended in the breeding apply introductory crossing with the use of Gissar rams to receive first-generation hybrids. Therefore, when managing these sheep, it is necessary to improve the applied feeding and keeping technology to the greatest extent. Characterizing the correlation between the most likely markers of resistance and productivity, current data indicated the possibility of simultaneous selection with respect to these qualities.

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References

[1] Gladyr E, Zinovieva N, Müller M and Brem G 2005 Investigation of the Russian sheep breeds using DNA microsatellites Proc. 56th Annual Meeting, European Association for Animal Production (EAAP) (Uppsala, Sweden) pp 100

[2] Dzadzovski I, Celeska E, Ulchar I, Janevski A, Kirovski D, Gladyr E, Zinovieva NA, Müller M and Brem, G 2015 Influence of the season on the metabolic profile in Chios sheep Macedonian Veterinary Review 38(2) 183-8

[3] Lawson Handley L-J, Byrne K, Santucci F, Townsend S, Taylor M, Bruford M W and Hewitt G M 2007 Genetic structure of European sheep breeds. Heredity 99(6) 620-31

[4] Tapio M, Micekienė I, Vilkiški J and Kantanen J 2003 Comparison of microsatellite and blood protein diversity in sheep: Inconsistencies in fragmented breeds Molecular Ecology 12(8) 2045-56

[5] Balcioğlu M S, Karśli T, Şahin E, Ulutaş Z and Aksoy Y 2014 Determination of calpastatin (CAST) gene polymorphism in some native sheep breeds reared in Turkey by PCR-RFLP method. TarimBilimleriDergisi 20(4) 427-33

[6] Delghani-Samani A and Madreseh-Ghahtarokhi S 2019 Evaluation of performance rate, some hematological and biochemical parameters in Iranian afshari breed fattened sheep fed diet containing Gundelia (Gundeliatournefortii L.) Iraqi Journal of Veterinary Sciences 33(1) 33-8

[7] Gorlov I F, Shirokova N V, Slozhennina M I, Mosolova N , Zlobina E Y, Kolosov Y A, Getmantseva L V, Bakoev N F, Leonova M A and Kolosov A Y 2018 GDF9 gene polymorphism and its association with litter size in two russian sheep breeds RendicontiLincei 29(1) 61-6

[8] Gutie´rez-Gil B, Arranz J J, Pong-Wong R, Garcı´a-Ga´mez E, Kijas J, et al 2014 Application of selection mapping to identify genomic regions associated with dairy production in sheep. PLoS ONE 9(5) e94623

[9] Calnan H B, Jacob R H, Pethick D W and Gardner G E 2014 Factors affecting the colour of lamb meat from the longissimus muscle during display: The influence of muscle weight and muscle oxidative capacity Meat Science 96(2) 1049-57

[10] Kulikova K A, Yuldashbaev Y A, Petrovic P, Petrovic V C, Muslic D R, Maksimovic N and Andric D O 2018 The polymorphism of CAST gene in rams populations of Tuvan breed Genetika 50(3) 885-93

[11] Mohamadnia A R, Azarpajou S, Beige N, Karimi I, Abdi A and Arabi M 2007 Anatomy of the hoof in sheep, a study to find a proper hoof trimming indices Journal of Veterinary Research 62 139-44

[12] Sabbioni A, Beretti V, Zambini E M, Superchi P and Ablondi M 2019 Allometric coefficients for physical-chemical parameters of meat in a local sheep breed Small Ruminant Research 174 141-7

[13] Gorlov I F, Mosolov A A, Knyazhechenko O A, Gishlarkaev E I, Garyaeva Kh B and Fedorov Yu N 2018 Qualitative indicators of beef and mutton obtained from animals raised on natural pastures Agricultural and Food Innovations 3(3) 20-5

[14] Gorlov I F, Mosolov A A, Yuldashbaev Yu A, Knyazhechenko O A and Gishlarkaev E I 2018 The fatty acid composition of the fat from rams and steers grown in the natural pastures of the Volga region Sheep, goats, wool 2 38-40

[15] Gorlov I F, Fedotova G V, Slozhennkina M I, Mosolova N I, Magomadov T A, Yuldashbaev Yu A, Alekseeva A A and Mosolova D A 2019 Productive and biological features of Edilbay rams of various genotypes bred in arid conditions of Low Volga Region Sheep, goats, wool 2 2-4