Peculiarities of metabolism of rams obtained from crossing ewes of Kalmyk fat-tailed breed with dorper rams

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Abstract. To increase the production of mutton, it is necessary to improve the genetic resources of sheep with precocity and high meat productivity. In this regard, the meat breed Dorper has gained its popularity, which has good meat qualities. The aim of this paper is to study the hematological parameters in the blood of the Kalmyk fat-tailed breed and hybrids (1/2 Kalmyk fat-tailed × ½ dorper). The work was carried out in LLC “Agrofirma Aduchi”, the Republic of Kalmykia in 2017. It is established that hybrids have a high content of hemoglobin, leukocytes, erythrocytes in the blood, which indicates the activation of redox processes in the body, and confirms their higher growth rates during cultivation. The content of total protein in the blood serum increased with age and was within the physiological norm. At 4 months of age, in the serum of lambs of group II, there was more total protein by 4.86 g/l (7.39%) (P > 0.95), and at 8 months of age – by 5.16 g/l (7.74%) (P > 0.99), than in peers of the control group. Crossbred calves were significantly superior to purebred animals also in blood serum, albumin, activity of aspartate aminotransferase, alanine aminotransferase and alkaline phosphatase. The activation of metabolic processes in the body of local sheep contributed to a high energy of growth in comparison with purebred peers of Kalmyk fat-tailed breed.

1. Introduction

To increase the production of mutton, it is necessary to improve the genetic resources of sheep with precocity and high meat productivity [1, 2, 3]. In this regard, the meat breed dorper gained its popularity [4, 5, 6].

Dorper sheep breed were brought to the Republic of Kalmykia in 2016. This breed is new in Russia, and there is little data on its use when crossing with other breeds. Therefore, the study of the effectiveness of crossing this breed with domestic breeds of sheep is an urgent problem.

In recent years, widespread development in animal husbandry received the doctrine of the interior of farm animals, that is, a set of internal, physiological, anatomical and biochemical properties in the organism in connection with its constitution and the direction of productivity.

A study of the interior gives one the possibility to explore internal structure of the body, to establish the development of different organs, tissues and systems, physiological and biochemical properties of the body, its constitutional features, formative processes in ontogenesis, to identify factors that can affect them.
However, the most common object of interior research is animal blood [7, 8, 9].

An important value of the blood is that, being in a continuous movement, it delivers nutrients to the cells and tissues of the body. In addition, blood carry metabolic products from cells, freeing them from all kinds of biochemical slag and harmful substances, and is involved in gas exchange [10].

Blood is internal environment of organism. Despite the continuous flow of various products into the blood and the removal of them, morphological and biochemical composition of the blood is normally quite constant. However, its composition is able to change, depending on various internal and external factors [11]. Therefore, by analyzing the composition of the blood, we can see all the changes occurring in the body.

The aim of the study was to study the peculiarities of the metabolism by morphological and biochemical parameters of blood of young growth of sheep obtained by crossing ewes of Kalmyk fat-tailed breed with rams of the dorper breed.

2. Material and methods of the study

Scientific and production experience was carried out in LLC “Agro-firma Aduchi” in 2017 according to the scheme presented in table 1.

| Group       | Breed            | Blood of the received posterity |
|-------------|------------------|---------------------------------|
| I – control | Ewes Kalmyk fat-tailed (KF) Rams Kalmyk fat-tailed (KF) | purebred (KF) |
| II – experimental | Ewes Kalmyk fat-tailed (KF) Rams Dorper (D) | (1/2 KF × 1/2 D) |

For the experiment, two groups (40 heads in each) of ewes of Kalmyk fat-tailed breed were formed according to the principle of pairs of analogues. Ewes in the group I were covered with rams of Kalmyk fat-tailed breed, and the ewes of group II by rams of breed dorper (experimental group). Lambing of ewes took place in April 2017. Ewes with lambs were kept on fattening on natural pastures. At the age of four months, the lambs were separated from the ewes. After separating the young sheep were kept in the pasture (fattening).

In order to study the changes of hematological indicators of lambs, blood were taken at the age of 4 and 8 months. Special vacuum tubes with different fillers were used for blood collection. The tubes for serum were painted in red and filled with a dry activator to form a clot during 10 to 30 minutes. Tubes for analysis of whole blood were purple and contained ETDA (etilendiaminova acid), which prevents blood clotting by blocking calcium ions.

Taking blood from lambs was carried out early in the morning before feeding from of the jugular vein.

Hematological studies were conducted in the Federal state budgetary institution “Stavropol interregional veterinary laboratory”.

Received experimental material was processed by biometric method of variation statistics.

3. Results of the study

Blood, circulating in the blood vessels of the body, carries a number of extremely important physiological functions, so it is very important to study its indicators.

The study of the morphological composition of the blood showed the significant differences between the experimental and control group (table 2).

| Indicator          | Group     | Norm   | 1 - control | II - experimental |
|--------------------|-----------|--------|-------------|-------------------|
|                    | 4 months age |        |             |                   |
| Hemoglobin, g/l    | 102.43±3.95 | 120.00±5.29 | 80-160       |                   |
| Leukocyte, thousand/μl | 10.25±1.11 | 12.96±0.48 | 6.0-14.0    |                   |
As a result of the tests, it was found that all morphological parameters of the blood of the experimental sheep were within the physiological norm.

Hemoglobin is one of the main indicators of oxidative and metabolic processes in the body of the animal, as it transports oxygen and carbon dioxide. In addition, hemoglobin has buffer properties, as well as the ability to bind toxic substances.

Hybrids obtained by crossing ewes of the Kalmyk fat-tiled breed with rams of the dorper breed had a large concentration of hemoglobin in the blood at 4 months of age by 17.15 % (P > 0.95), and 8 months of age by 8.78 % (P > 0.99).

By the number of leucocytes was also an advantage in crossbred animals. Its blood contained more leucocytes at 4 and 8 months of age by 26.44 % (P > 0.95) and 17.33 % (P > 0.95), respectively.

The differences between the groups were insignificant in the content of ESR.

Erythrocytes perform respiratory function, take an active part in the regulation of acid-base balance of the body, adsorption of toxins and antibodies, as well as in a number of enzymatic processes.

In our experience, the content of erythrocytes in the blood of animals of the second group was higher at 4 months of age - by 16.93 % (P > 0.95), and at 8 months of age - by 22.49 % (P > 0.99).

Leukogram analysis is the most valuable method of clinical research. In the leukogram, such changes are often found that occur long before the clinical signs of the disease appear and indicate serious changes in the course of the developing pathological process in the body.

The study of leukocyte formula showed the absence of statistically significant differences between the animals of experimental and control groups (table 3).

**Table 3.** Leukocyte formula of experimental sheep (n=10).

| Indicator      | Group  | Norm   |
|----------------|--------|--------|
|                | I – control | II - experimental |     |
| Neutrophils    |        |        |
|                | At the age of 4 months |             |        |
| segmented      | 44.6±0.70 | 45.3±0.62 | 40-48 |
| stab           | 2.10±0.18 | 2.23±0.20 | 2-4   |
| Basophil       | 0.60±0.16 | 0.67±0.15 | 0-1   |
| Monocytes      | 3.40±0.34 | 2.90±0.31 | 2-6   |
| Eosinophils    | 2.20±0.29 | 2.30±0.33 | 1-4   |
| Lymphocytes    | 47.10±0.69 | 46.60±0.43 | 40-50 |
| Neutrophils    |        |        |
|                | At the age of 8 months |             |        |
| segmented      | 44.90±0.60 | 44.60±0.54 | 40-48 |
| stab           | 2.92±0.16 | 2.53±0.27 | 2-4   |
| Basophil       | 0.23±0.04 | 0.67±0.11 | 0-1   |
| Monocytes      | 3.00±0.30 | 3.20±0.33 | 2-6   |
| Eosinophils    | 2.15±0.24 | 2.60±0.31 | 1-4   |
| Lymphocytes    | 46.80±0.59 | 46.40±0.76 | 40-50 |

The function of basophils is reduced to the synthesis of heparin and histamine.

The main functions of neutrophils are to carry out phagocytosis in the body: they destroy harmful particles by absorbing it and “digesting” it.

The function of monocytes is to protect the body against microbial infection; toxic effect of metabolites of macrophages on parasites in the animal body; participation in the immune response of the body and inflammation; re-generation of tissues and anti-tumor protection; regulation of
hematopoiesis; the phagocytosis of old and damaged blood cells, regulation of products acute-phase protein by the liver.

In our studies, all indicators were within the physiological norm, which indicates the absence of degenerative changes in the cells of the body. Nuclear shift of neutrophils was not observed, indicating the absence of infectious and inflammatory processes in the body.

Thus, the increased content in the blood of crossbreed young sheep of hemoglobin, leukocytes, erythrocytes indicates the activation of redox processes in its body, which confirms their higher growth rates during cultivation.

The results of biochemical parameters of blood of experimental lambs are presented in table 4.

**Table 4. Biochemical parameters of blood serum of young sheep.**

| Indicator            | Group I At the age of 4 months | Group II At the age of 8 months | Group I At the age of 8 months | Group II At the age of 8 months |
|----------------------|--------------------------------|---------------------------------|--------------------------------|---------------------------------|
| Protein, g/l         | 65.72±1.22                     | 70.58±1.43                     | 66.65±1.31                     | 71.81±1.22                     |
| Albumen, g/l         | 27.32±0.82                     | 29.99±0.70                     | 26.36±0.53                     | 30.63±1.02                     |
| Globulin, g/l        | 38.40±1.87                     | 40.59±1.47                     | 40.29±1.16                     | 41.18±1.19                     |
| The activity of alkaline phosphatase, µ/L | 112.83±2.57                     | 122.59±3.49                     | 113.63±2.50                     | 119.83±1.82                     |
| Alt, U/L             | 16.09±0.71                     | 17.96±0.49                     | 22.06±0.84                     | 30.37±1.23                     |
| AST, U/L             | 57.30±1.53                     | 61.16±0.83                     | 58.12±1.44                     | 62.04±1.13                     |
| Bilirubin total, µ mol/l | 3.09±0.16                     | 3.61±0.26                     | 4.30±0.22                     | 4.02±0.28                     |
| Glucose, mmol/l      | 2.39±0.12                     | 2.25±0.18                     | 2.36±0.12                     | 2.49±0.34                     |
| Cholesterol, mmol/l  | 1.63±0.10                     | 1.70±0.14                     | 1.89±0.04                     | 1.98±0.10                     |
| Urea, mmol/l         | 3.30±0.16                     | 3.50±0.19                     | 5.17±0.56                     | 5.51±0.11                     |
| Triglyceride, mmol/l | 0.70±0.04                     | 0.74±0.04                     | 0.76±0.02                     | 0.78±0.03                     |
| Alkaline reserve, turn%CO₂ | 51.40±0.77                     | 54.82±1.10                     | 49.08±1.09                     | 52.63±0.95                     |
| Creatinine, µ mol/l  | 57.04±4.72                     | 59.61±3.06                     | 71.58±1.01                     | 73.91±2.39                     |
| Iron, µ mol/l        | 18.01±0.48                     | 18.80±0.42                     | 18.81±0.56                     | 19.04±0.34                     |
| Potassium, mmol/l    | 4.45±0.19                     | 4.59±0.16                     | 4.40±0.22                     | 4.13±0.22                     |
| Calcium, mmol/l      | 3.26±0.11                     | 3.57±0.28                     | 2.78±0.03                     | 2.70±0.04                     |
| Magnesium, mmol/l    | 0.87±0.07                     | 0.96±0.08                     | 1.24±0.06                     | 1.12±0.04                     |
| Sodium, mmol/l       | 141.44±1.48                    | 146.92±3.02                    | 139.10±1.86                    | 139.40±0.93                    |
| Phosphorus, mmol/l   | 1.57±0.12                     | 1.55±0.11                     | 1.57±0.06                     | 1.51±0.04                     |
| Chlorides, mmol/l    | 101.4±2.16                    | 102.67±2.27                    | 111.26±1.4                    | 112.32±0.86                    |

Total protein in the blood serum reflects the exchange processes in the body to identify and defines the productivity of animals. In addition, the proteins of the blood perform a plastic function, transfers the nutritional properties for normal vital activity of the body, proteins carry out the protection function of the body [2]. Finding of this indicator within the normal range indicates the absence of infectious and inflammatory processes in the body.

It is known that serum albumins, as well as the total protein, are in correlation with the growth speed of animals and are directly related to the intensity of redox processes in the body.

This index was the highest in young sheep of group II. Its superiority over the peer of group I was in 4-month age of 9.77% (P > 0.95) and 8-month – 16.20% (P > 0.99).

Globulins are also important in the life of the body and perform a protective function as carriers of antibodies.

The content of globulins in blood serum of cross-bred young sheep was higher than in the control group at the age of four months by 5.70%, and at the age of eight months by 2.21%, however, the marked difference is statistically unreliable.
One more important parameter, which worth paying attention – urea (the final product of protein metabolism in the body). Since it is excreted by the kidneys, the determination of its concentration in the blood gives an idea of the functional ability of the kidney and the most widely is used for diagnostics of renal pathology.

Our studies found that the activity of alkaline phosphatase in sheep of experimental groups was within the physiological norm in all studied periods. In cross-bred lambs, this rate was higher than in purebred lambs at the age of 4 months by 8.65% (P > 0.95) and 8-months old lambs by 5.45% (P > 0.95).

The activity of aspartate aminotransferase (AST) and alanine aminotransferase (ALT) was within the normal physiological state, which indicates the absence of pathological conditions in the functioning of the liver and heart of animals. However, the crossbred young sheep were more related to high activity of enzymes of transamination and exceeded of purebred peers at the age of 4 months by ALT and AST for 11.62 (P > 0.95) and 6.74% (P > 0.95) and eight months age, respectively – by 37.66 (P > 0.999) and 6.74% (P > 0.95).

The content of bilirubin, glucose, cholesterol in the serum of sheep of all experimental groups was within the physiological norm.

A small content of urea indicates the intensity of protein metabolism. At the age of 4 months, purebred lambs had a urea content of 3.3 mmol/l, and hybrids 3.5 mmol/l, by 8 months of age increased to 5.17 and 5.51 mmol / l, respectively.

Crossbred young sheep had a high alkaline reserve. It outperformed purebred peers of the control group at 4 and 8 months of age by 3.42 and 3.55 turn%CO₂, respectively.

Creatinine is the end product of the creatine phosphate reaction. Creatinine is formed in the muscles and then released into the blood. Creatinine is involved in the energy metabolism of muscle and other tissues. In our experience, creatinine levels in serum were higher in group II of animals than in control group I of sheep at 4 and 8 months age by 4.51 and 3.25%, respectively.

It is important to examine the macronutrients of blood, determining the phosphorus in biochemical blood test is necessary stage of diagnosis of bone diseases, kidneys, the parathyroid glands. Magnesium is a vital mineral that is involved in the production of energy, muscle contraction, nerve impulse feeding, and the construction of the skeleton of bones.

Calcium supports a normal heart rate, as well as magnesium, and contributes to the health of the cardiovascular system as a whole. It also participates in the metabolism of iron in the body, regulates enzyme activity and contributes to the normal functioning of the nervous system, the transmission of nerve impulses. Phosphorus and calcium make bones strong and teeth healthy. Calcium is involved in blood clotting, involved in muscle contraction.

Our studies found that the content of iron, calcium, potassium, phosphorus, sodium, magnesium, were within normal limits, which indicates a full-fledged balanced feeding of the young sheep.

4. Conclusion

On the basis of conducted study we can conclude that by crossing ewes of the Kalmyk fat-tailed breed with rams of the dorper breed, the effect of heterosis appears, as evidenced by a significant increase in the blood of crossbred of young sheep of hemoglobin, leukocytes, erythrocytes, total protein, albumin, aspartate aminotransferase activity (AST), alanine aminotransferase (AST) and alkaline phosphatase, which indicates the activation of the redox processes in their organism and is confirmed by its higher rates of growth and development during rearing, compared to purebred peers of Kalmyk fat-tailed breed.

References

[1] Pogodaev V, Arilov A, Aduchiev B, Komlatsky V, Edgeev V 2017 Research Journal of Pharmaceutical, Biological and Chemical Sciences RJPBCS 8 6 pp 515–519

[2] V Pogodaev, A Arilov, B Aduchiev, V Komlatsky, V Edgeev 2018 Research Journal of Pharmaceutical, Biological and Chemical Sciences RJPBCS 9 3 pp 765–769
[3] Pogodaev V, Aduchiev B, Ratoshny A, Lidzhiev E, Ulyumdzhiev A 2018 Research Journal of Pharmaceutical, Biological and Chemical Sciences RJPBCS 9 3 pp 776–781

[4] Souza D, Selaive-Villarroel A, Pereira E, Osório J, Teixeira A 2013 Small Ruminant Research 114 1 pp 51-55 doi.org/10.1016/j.smallrumres.2013.06.006

[5] Chaves Figueiredo G, Paulo Gonçalves de Rezende M, Pereira de Figueiredo M, Bozzi R, Henrique Mendes Malhado C 2019 Small Ruminant Research 170 pp 143-148 doi.org/10.1016/j.smallrumres.2018.11.024

[6] Lotfollahzadeh S, Zakian A, Tehrani-Sharif M, Watson D G 2016 Small Ruminant Research 145 pp 58-64 doi.org/10.1016/j.smallrumres.2016.10.012

[7] Kovacik A, Arvay J, Tusimova E, Harangozo L, Massanyi P 2017 Chemosphere 168 pp 365-371 doi.org/10.1016/j.chemosphere.2016.10.090

[8] Pogodaev V, Aduchiev B, Marchenko V, Nesterenko M, Belkina E 2018 Research Journal of Pharmaceutical, Biological and Chemical Sciences 9 4 pp 671–675

[9] Rykaczewska A, Gajęcka M, Dąbrowski M, Wiśniewska A, Zielon Ł 2018 Toxicon 152 pp 84-94 doi.org/10.1016/j.toxicon.2018.07.013

[10] Souza D, Selaive-Villarroel A, Pereira E, Silva E, Oliveira R 2016 Small Ruminant Research 145 pp 76-80 doi.org/10.1016/j.smallrumres.2016.10.017

[11] Malhado C, Carneiro P, Affonso P, Souza A, Sarmento J 2009 Small Ruminant Research 84 1–3 pp 16-21 doi.org/10.1016/j.smallrumres.2009.04.006