Meat productivity and interior features of mongrel lambs (½ Kalmyk fat tailed + ½ Dorper) at intense feeding

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Abstract. The purpose of the study was to assess the efficiency of crossing the ewes of Kalmyk fat tailed breed with the rams of the Dorper breed to create a new genotype of the purebred sheep, as well as to assess the productive qualities and interior features of the first generation cross breed during intensive feeding in the conditions of the arid zone of Kalmykia. It was established that the crossbred rams have the best feed-efficiency by the body weight gain. In two months of feeding they consumed less dry matter per 1 kg of the body weight gain than the purebred animals by 2.11 kg, energetic feed unit (EFU) – by 2.17, exchange energy – by 21.67 MJ, crude protein – by 354.26 g. The cross breed of the experimental group showed a significantly higher content of total protein, alkaline phosphatase, AST and ALT enzymes transamination in the blood and serum during all periods of the study indicating the activation of redox processes in animals. The crossbred rams significantly surpassed their purebred herdmates in terms of preslaughter body weight by 11.07 kg, chilled carcass weight – by 5.37 kg, slaughter weight – by 5.18 kg, boneless meat weight in carcass – by 4.86 kg, loin eye area – by 3.54 cm².

1. Introduction
Sheep farming is one of the most profitable activities in the field of agriculture.

Today, under the conditions of reduction in prices and demand for wool, the development of the sheep farming industry and the increase of its competitiveness are bound to meat productivity, since lamb meat is currently in demand on the world market [1–3].

The economic efficiency of sheep farms is associated with the increase of lamb production. In this context, it is necessary to improve the genetic resources of sheep with rapid and high meat productivity. Hence, the Dorper meat breed has gained its popularity [4, 5].

In 2016, Dorper breed rams were brought to the Republic of Kalmykia. In the Russian Federation, this breed is new and there is little data on its use when crossing with other breeds. Therefore, the study of the crossing efficiency of this breed with domestic sheep breeds seems quite relevant.

Numerous studies revealed that when crossed not every combination of breeds gives a positive result [6–8]. In the practice of domestic sheep farming, the optimal schemes of mixed crossing, taking into account breeds and regions of their farming, have not yet been developed. The study of the
economic character of the Dorper breed and its crossing with other breeds in Russia has not previously been carried out, and there is no data on this issue in the available literature.

However, this breed is more popular abroad and has been studied by a number of scientists [9–13].

Given all the complexity and range of earlier studies, the issues of improving the meat qualities of the Kalmyk fat tailed sheep breed using the Dorper breed have not been previously studied. Therefore, the study of the crossing efficiency of this breed with domestic sheep breeds seems quite relevant.

The purpose of the study was to assess the efficiency of crossing the ewes of Kalmyk fat tailed breed with the rams of the Dorper breed to create a new genotype of the purebred sheep, as well as to assess the productive qualities and interior features of the first generation cross breed during intensive feeding in the conditions of the arid zone of Kalmykia.

2. Materials and methods

The scientific experiment was carried out at LLC Agrofirma Aduchi, Russia in 2017-2018 according to the scheme presented in Table 1.

| Group         | Breed       | Pedigree of obtained progeny |
|---------------|-------------|------------------------------|
| I-control     | Kalmyk fat tailed | Kalmyk fat tailed           |
| II-experimental | Kalmyk fat tailed | Dorper                      |
|               |             | ½ Kalmyk fat tailed + ½ Dorper |

Two groups of Kalmyk fat tailed sheep were formed following the principle of the pairs of analogues, 100 heads each. The I group of female sheep was crossed with Kalmyk fat tailed rams, and the II group – with Dorper rams (experimental group). The lambing of sheep took place in April 2018. Until four months of age, the lambs were kept with ewes in natural pastures. The lambs were then weaned from their ewes. After weaning, two experimental groups of rams were formed, 22 heads in each, which were stall feed. The fattenning was carried out until 6 months of age. At the end of fattening the control slaughter of 3 rams from each group was carried out.

In order to account the growth of animals, monthly weighing (in the morning before feeding) was carried out, on the basis of which the absolute, average daily and relative body weight gains were calculated.

Blood samples were taken to study the hematological parameters of lambs.

The analyses were performed at Stavropol Interregional Veterinary Laboratory.

Slaughter and meat qualities of young animals were studied according to generally accepted methods.

To determine the morphological composition, the carcasses were subject to complete dissection after cooling at a temperature from 0 to +4°C. On the basis of the dissection, the yield of the trimmed meat, i.e. muscle tissue without bones, connective, fat tissues and cords, as well as the boneless meat yield per 1 kg of bones, cartilage and cords, was determined. The loin eye area was determined by measuring the cut print of the rib eye between the 12th and 13th vertebrae on a special cleared paper.

After animal slaughter, their meat productivity was assessed against absolute and relative indicators.

The resulting experimental material was processed with the biometric method of variation statistics.

3. Results and discussion

The results of our studies showed that the body weight of lambs during breeding was different in the experimental and control groups (Table 2).

During the suckling period, the crossbred young animals enjoyed superiority in the body weight over their herdmates obtained through pure breeding. Thus, at birth the difference was 0.56 kg (P>0.999), at the age of 1 month – 1.53 kg (P>0.999), at the age of 2 months – 2.16 kg (P>0.999), at
the age of 3 months – 3.72 kg (P>0.999), at the age of 4 months – 6.19 kg (P>0.999).

After weaning, the rams were placed for the control fattening. While fattening, the body weight of rams of the I group was 27.98 kg and that of their herdmates of the experimental group – 34.17 kg.

At the age of five months the crossbred rams exceeded the purebred rams by 9.35 kg (P>0.999), and at the age of six months – by 11.18 kg (P>0.999).

A similar pattern was observed for absolute, average daily and relative gains. In total over the suckling period the difference in the absolute gain was 5.63 kg, in the average daily gain – 46.92 g, in the relative gain – 52.94 abs % in favor of crossbred young sheep.

### Table 2. Growth rate of experimental rams, n=2

| Age            | I-control | Group | II-experimental |
|----------------|-----------|-------|-----------------|
| biometric index | body weight, kg | absolute gain, kg | average daily gain, g | relative gain, % | body weight, kg | absolute gain, kg | average daily gain, g | relative gain, % |
| At birth       | M 4.39 ±0.12 | - | - | 4.95 | - | - | - | - |
| 1              | m 3.72 ±0.10 | 8.45 ±3.50 | 281.67 ±4.59 | 192.48 ±0.15 | 14.37 ±0.15 | 9.42 ±0.07 | 281.67 ±0.10 | 192.48 ±0.15 | 14.37 ±0.15 | 9.42 ±0.07 |
| 2              | M 18.96 ±0.20 | 6.12 ±2.07 | 204.00 ±0.15 | 47.66 ±0.17 | 21.12 ±0.42 | 6.75 ±0.13 | 204.00 ±0.15 | 47.66 ±0.17 | 21.12 ±0.42 | 6.75 ±0.13 |
| 3              | m 23.63 ±0.24 | 4.67 ±0.06 | 155.67 ±0.10 | 24.63 ±0.17 | 27.35 ±0.09 | 6.23 ±0.13 | 24.63 ±0.17 | 27.35 ±0.09 | 6.23 ±0.13 | 24.63 ±0.17 |
| 4              | M 27.98 ±0.25 | 4.35 ±0.06 | 145.00 ±0.15 | 18.41 ±0.18 | 34.17 ±0.09 | 6.82 ±0.13 | 18.41 ±0.18 | 34.17 ±0.09 | 6.82 ±0.13 | 18.41 ±0.18 |
| 5              | m 34.72 ±0.30 | 4.61 ±0.07 | 196.58 ±0.19 | 224.67 ±0.19 | 537.36 ±0.19 | 44.96 ±0.19 | 224.67 ±0.19 | 537.36 ±0.19 | 44.96 ±0.19 | 224.67 ±0.19 |
| 6              | M 34.72 ±0.33 | 6.74 ±0.10 | 224.67 ±0.13 | 224.67 ±0.13 | 537.36 ±0.13 | 44.96 ±0.13 | 224.67 ±0.13 | 537.36 ±0.13 | 44.96 ±0.13 | 224.67 ±0.13 |
| 7              | m 40.56 ±0.34 | 5.84 ±0.15 | 194.67 ±0.30 | 194.67 ±0.30 | 517.41 ±0.30 | 16.82 ±0.30 | 194.67 ±0.30 | 517.41 ±0.30 | 16.82 ±0.30 | 194.67 ±0.30 |
| Total over the suckling period | M – 23.59 ±0.19 | 196.58 ±0.19 | 537.36 ±0.19 | 44.96 ±0.19 | 34.17 ±0.19 | 6.82 ±0.18 | 34.17 ±0.19 | 6.82 ±0.18 | 34.17 ±0.19 | 6.82 ±0.18 |
| Total over the fattening period | m – 23.59 ±0.19 | 196.58 ±0.19 | 537.36 ±0.19 | 44.96 ±0.19 | 34.17 ±0.19 | 6.82 ±0.18 | 34.17 ±0.19 | 6.82 ±0.18 | 34.17 ±0.19 | 6.82 ±0.18 |
| Total over the entire period | M – 36.17 ±0.24 | 209.67 ±0.24 | 537.36 ±0.24 | 44.96 ±0.24 | 34.17 ±0.24 | 6.82 ±0.24 | 34.17 ±0.24 | 6.82 ±0.24 | 34.17 ±0.24 | 6.82 ±0.24 |

During the fattening period, in terms of the absolute body weight gain the crossbred rams exceeded the purebred animals by 4.99 kg, in average daily gain – by 83.16 g, in the relative gain – by 6.46 abs %, and during the entire growing period – by 10.62 kg, 59 g and 121.34 abs %, respectively.

The feed-efficiency of animals is extremely important to increase the economic efficiency of sheep production.

The results of our studies showed that the cost of fodder per 1 kg of gain in purebred animals is higher than that of the crossbred animals (Table 3).

Thus, in the first month of fattening, they consumed 6.64 kg of dry matter, 6.48 EFU, 64.81 MJ of exchange energy, 1054.60 g of crude protein, 217.40 g of crude fat and 1549.10 g of crude fiber, which is more than that of the crossbred animals by 1.89 kg, 1.87 EFU, 18.74 MJ, 305.31 g, 62.65 g and 425.87 g, respectively.

In the second month of fattening, the consumption of nutrients of the crossbred animals was lower: dry matter – by 2.16 kg, EFU – by 2.28; exchange energy – by 22.83 MJ; crude protein – by 375 g; crude fat – by 74.9 g and crude fiber – by 433.56.

Over only two months of fattening, they consumed less dry matter per 1 kg of the body weight gain
than the pure animals – by 2.11 kg, EFU – by 2.17, exchange energy – by 21.67 MJ, crude protein – by 354.26 g, crude fat – by 71.65 g and crude fiber – by 446.52 g.

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

The leukogram analysis is the most valuable method of clinical study. The leukogram often shows changes that occur long before the manifestation of clinical signs of a disease and indicate serious shifts during the developing pathological process in the body.

Table 3. Feed and nutrient costs per 1 kg of body weight gain on fattening

| Indicator                | Group       |
|--------------------------|-------------|
|                          | I-control   | II-experimental |
| **First month of fattening (31 days)** |             |                |
| Consumption per 1 kg of body weight gain: |             |                |
| - dry matter, kg         | 6.64        | 4.75           |
| - EFU                    | 6.48        | 4.61           |
| - exchange energy, MJ    | 64.81       | 46.07          |
| - crude protein, g       | 1054.60     | 749.29         |
| - crude fat, g           | 217.40      | 154.75         |
| - crude fiber, g         | 1549.10     | 1123.23        |
| **Second month of fattening (31 days)** |             |                |
| Consumption per 1 kg of body weight gain: |             |                |
| - dry matter, kg         | 10.28       | 8.12           |
| - EFU                    | 10.58       | 8.30           |
| - exchange energy, MJ    | 105.83      | 83.00          |
| - crude protein, g       | 1726.37     | 1351.37        |
| - crude fat, g           | 350.00      | 275.10         |
| - crude fiber, g         | 2173.46     | 1739.90        |
| **Total over two months** |             |                |
| Consumption per 1 kg of body weight gain: |             |                |
| - dry matter, kg         | 8.33        | 6.22           |
| - EFU                    | 8.39        | 6.22           |
| - exchange energy, MJ    | 83.86       | 62.19          |
| - crude protein, g       | 1366.38     | 1012.12        |
| - crude fat, g           | 278.94      | 207.29         |
| - crude fiber, g         | 1838.95     | 1392.43        |

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The study of the white cell count (WCC) revealed the absence of statistically significant differences between purebred and crossbred animals (Table 4).

In our studies, all indicators of the white cell count were within the physiological norm indicating that there were no degenerative changes in the cells. No nuclear shift of neutrophils was observed indicating the absence of infectious and inflammatory processes in the body.

The total protein content in the blood serum reflects the state of metabolic processes in the body and determines the productivity of animals. Besides, blood proteins perform the body protective function.

The activity of aspartate transaminase (AST) and alanine transaminase (ALT) in the blood serum of experimental rams is shown in Figure 1.

As a result of the experiment, the rams showed differences in the dynamics of blood serum indices. Thus, at the age of 4 months the content of ALT and ACT in the animals of the II group was higher than in the I group by 0.38 and 1.26 u/l.
Table 4. WCC of experimental sheep (n=5)

| Indicator    | Group | Reference level |
|--------------|-------|-----------------|
|              | I     | II              |                  |
|              | at the age of 4 months |                |                  |
| Neutrophils: |       |                 |                  |
| segmentonuclear banded | 43.60±1.03 | 44.00±0.71 | 40-48           |
| Basophils    | 0.54±0.09 | 0.54±0.09 | 0-1             |
| Lymphocytes  | 46.00±0.71 | 44.60±1.21 | 40-50           |
| at the age of 6 months |       |                 |                  |
| Neutrophils: |       |                 |                  |
| segmentonuclear banded | 41.80±0.80 | 45.20±1.24 | 40-48           |
| Basophils    | 0.24±0.07 | 0.24±0.05 | 0-1             |
| Lymphocytes  | 48.40±0.68 | 45.40±1.17 | 40-50           |

Figure 1. Dynamics of transamination enzymes in the blood serum of rams

By the age of six months, this trend was still persistent. The ALT and AST content was higher in the crossbred young sheep by 10.06 and 9.04 u/l than in the purebred herdmates.

The data on blood serum protein composition of experimental rams during the second experiment are shown in Figure 2.

Figure 2. Content of total protein and protein fractions in the blood serum of rams
In level of total protein and albumins in the II experimental group at the age of 4 months was higher by 0.2 g/l and 0.8 g/l, respectively, and globulins – lower by 0.6 g/l.

At the age of 6 months, this trend was still persistent. Thus, the purebred rams lagged behind the crossbred rams in terms of the total protein content by 0.32 g/l and albumins by 4.12 g/l, and in terms of globulin content they exceeded the animals of the II group by 3.8 g/l.

The results of blood serum biochemical composition of experimental rams are given in Table 5.

In the control group, the alkaline phosphatase activity was lower than in the experimental group at 4 months of age by 4.34 u/l (P>0.95) and at 6 months of age – by 6.62 u/l (P>0.95).

The content of total bilirubin, glucose, cholesterol and triglycerides in the blood serum of the rams of both groups was within the norm, as was the content of macro- and microelements, which indicates a full balanced feeding of young animals.

The urea content was higher in the rams of the II group both at 4 and 6 months of age by 0.08 and 0.6 mmol/L, respectively.

The createnin content in the blood serum of the crossbred animals (1/2 of Kalmyk fat tailed + 1/2 Dorper) exceeded the same value in the purebred Kalmyk fat tailed rams aged 4 months by 2.14 micron mol/L, and aged 6 months – by 5.98 micron mol/L.

At 4 months of age, the alkali reserve was lower than of purebred rams by 1.38 vol. % CO₂, and at 6 months of age this indicator was higher than in the animals of the I group – by 2.6 vol. % CO₂.

The results of control slaughter of experimental rams are given in Table 6.

The obtained data show the differences in meat productivity of control and crossbred animals (Figure 3).
The slaughter at the age of 6 months, after 2 months of feeding, showed that the crossbred rams outperformed their purebred herdmates in almost all slaughter indicators (Figure 3). Thus, the preslaughter body weight of animals of the II group was higher than that of the I one by 11.07 kg (P>0.999), chilled carcass weight – by 5.37 kg (P>0.99), slaughter weight – by 5.18 kg (P>0.99), and slaughter yield – by 0.91 abs %. In the control group the weight of internal fat was higher by 0.13 kg (P>0.95) indicating that the feed energy was spent on the formation of the muscle tissue rather than the fat tissue.

Besides, it should be noted that the first generation crossbred animals (II group) had no fat tail.

![I group](image1) ![II group](image2)

Figure 3. Carcasses of purebred and crossbred rams after feeding

Table 7 shows data on the morphological composition of ram carcasses after fattening.

| Indicator                        | Group   | I   | II   |
|----------------------------------|---------|-----|------|
| Chilled carcass weight, kg       |         | 17.03±0.64 | 22.40±0.72 |
| Muscle tissue weight, kg         |         | 9.70±0.95  | 16.07±0.71  |
| Basting fat weight, kg           |         | 2.79±0.13  | 2.58±0.26   |
| Broadtail fat weight, kg         |         | 1.30±0.04  | –             |
| Total fat tissue, kg             |         | 4.09±0.22  | 2.58±0.15   |
| Total fat weight, kg             |         | 13.79±0.81 | 18.65±0.71  |
| Weight of bones, cartilages and cords, kg |         | 3.24±0.20 | 3.79±0.17 |
| Muscle tissue yield, %           |         | 56.96±3.31 | 71.74±0.87  |
| Fat yield, %                     |         | 24.02±0.38 | 11.52±0.28  |
| Boneless meat yield, %           |         | 80.97±1.66 | 83.26±0.52  |
| Yield of bones, cartilages and cords, % |         | 19.03±0.45 | 16.92±0.26  |
| Muscle tissue yield per 1 kg of bones, cartilages and cords, % |         | 2.99±0.10 | 4.24±0.03 |
| Boneless meat yield per 1 kg of bones, cartilages and cords, % |         | 4.26±0.02 | 4.92±0.04 |
| Fat yield per 1 kg of bones, cartilages and cords, % |         | 1.26±0.01 | 0.68±0.01 |
| Loin eye area, cm²               |         | 18.95±0.17 | 22.49±0.25  |

The rams of the II group exceeded the purebred herdmates of the I group in the chilled carcass weight by 5.37 kg (P>0.99), in the muscle tissue weight – by 6.37 kg (P>0.99), in the boneless meat weight – by 4.86 kg (P>0.99), in the weight of bones, cartilages and cords – by 0.55 kg.

It should be noted that the crossbred rams show an increase in the number of ribs up to 14 pairs, while the purebred animals – up to 13 pairs.
The relative muscle tissue yield in the purebred rams was lower by 14.79 abs % (P>0.99), the boneless meat yield – by 2.39 abs %, and the yield of fat and bones was higher by 12.55 abs % (P>0.999) and 2.11 abs % (P>0.99), respectively.

The crossbred animals surpassed their herdmates of the I group in terms of the muscular tissue yield per 1 kg of bones, cartilages and cords by 1.25 abs % (P>0.999), in boneless meat yield per 1 kg of bones, cartilages and cords – by 0.66 abs % (P>0.999), and in the fat yield per 1 kg of bones, cartilages and cords they lagged behind the purebred rams by 0.58 abs % (P>0.999).

As for the loin eye area (cross-section of the rib eye), which indirectly determines the meat content in the carcass, this indicator was higher in the crossbred animals of the II group by 3.54 cm² (P>0.999).

4. Conclusion
Thus, it can be concluded that the crossbred young animals obtained from the crossing of the Kalmyk fat tailed sheep with the Dorper breed ram has an increased growth energy and surpasses its purebred herdmates of Kalmyk fat tailed breed with high reliability. Crossbred rams have the best feed-efficiency due to their body weight gain.

During all periods of the study the content of total protein, alkaline phosphatase, AST and ALT transamination enzymes in the blood and serum of the crossbred animals of the experimental group was significantly higher indicating the activation of redox processes in the animal body.

The crossbred rams have high slaughter and meat qualities. When slaughtered after fattening, the crossbred rams were reliably surpassed their purebred herdmates in terms of preslaughter body weight, chilled carcass weight, slaughter weight, boneless meat weight, the loin eye area. The first generation crossbred animals had no fat tail.

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