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Original Article

The Dorper breed as a stage in the sustainable development of the agroindustry

A raça Dorper como etapa do desenvolvimento sustentável da agroindústria

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Abstract

The economic condition, national economic significance and prospects for the development of sheep breeding in our country directly depend on the meat productivity of sheep. The purpose of our research was to study the qualitative indicators of sheepskins and the histological structure of the skin of Kalmyk fat-tailed rams and crossbreeds obtained on the basis of crossing of Kalmyk fat-tailed ewes with Dorper rams. The work was carried out in LLC "Agrofirma Aduchi", Republic of Kalmykia. It was found that the coarser wool of the rams of group I was 4.7 microns or 12.9%, in contrast to the peers of group II. The control animals have 40 quality wool, and the experimental ones - 36, that is, the wool of hybrid young animals is thinner by two whole qualities, which is a very good indicator for the textile industry. The fineness of the awn was thicker in purebred rams by 8.5%, the fineness of transitional hair and fluff by 17.8%, in contrast to hybrid young. In the study of the histological parameters of the skin, it was revealed that the rams of group I had 352.57 μm thicker skin (14.52%) in comparison with their peers in group II. In this case, the thickness of the layers of the total thickness of the skin in animals of group I is: epidermis - 0.8%, pilar - 69.8%, reticular - 29.4%; Group II - epidermis - 1.2%, pilar - 60.5%, reticular - 38.3%. The densest epidermis was found in crossbred young animals of group II. Their superiority in this indicator over their peers in the control group was 6.12 microns or 27.7%. This is due to the fact that in animals of the meat direction, the epidermal part (flesh) is thicker. Crossbred rams have a larger area of sheepskins, the skin is more elastic, durable and less thick, such sheepskins are first-class raw materials for the industrial production of fur products. The density of the coat (the ratio of WF / PF) in crossbred rams is greater than that of purebred peers.

Keywords: sheep, Dorper breed, crossing, rams, wool quality, skin histology.

Resumo

A situação económica, a importância económica nacional e as perspectivas de desenvolvimento da ovinocultura no nosso país dependem diretamente da produtividade da carne ovina. O objetivo desta pesquisa foi analisar os indicadores qualitativos da pele de carneiro e a estrutura histológica da pele de carneiros de cauda gorda Kalmyk e cruzamentos obtidos a partir do cruzamento de ovelhas de cauda gorda Kalmyk com carneiros Dorper. O trabalho foi realizado na LLC "Agrofirma Aduchi", República da Calmúquia. Verificou-se que a lã mais grossa dos carneiros do grupo I era de 4,7 mícrons ou 12,9%, em contraste com os pares do grupo II. Os animais do grupo "controle" apresentaram 40 lãs de qualidade, e os experimentais - 36, ou seja, a lã dos animais jovens híbridos é mais fina em duas qualidades inteiras, o que é um indicador muito bom para a indústria têxtil. A finura da asa foi mais espessa em carneiros de raça pura em 8,5%, a finura do cabelo de transição e penugem em 17,8%, em contraste com os jovens híbridos. No estudo dos parâmetros histológicos da pele, foi possível constatar que os carneiros do grupo I apresentaram pele 352,57 μm mais espessa (14,52%) em comparação com seus pares do grupo II. Nesse caso, a espessura das camadas da espessura total da pele nos animais do grupo I é: epiderme - 0,8%, pilar - 69,8%, reticular - 29,4%; Grupo II - epiderme - 1,2%, pilar - 60,5%, reticular - 38,3%. A epiderme mais densa foi encontrada em animais jovens mestiços do grupo II. A sua superioridade neste indicador sobre os seus pares no grupo de controlo foi de 6,12 mícrons ou 27,7%. Isso se deve ao fato de que nos animais do ramo cárneo a parte epidérmica (carne) é mais espessa. Os carneiros mestiços possuem maior área de pele de carneiro, a pele é mais elástica, durável e menos espessa, essas peles de carneiro são matéria-prima de primeira classe para a produção industrial de peles. A densidade da pelagem (relação WF / PF) em carneiros mestiços é maior do que em carneiros de raça pura.

Palavras-chave: ovinos, raça Dorper, cruzamento, carneiros, qualidade da lã, histologia da pele.

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1. Introduction

Sheep are one of the few animals that are bred to obtain not only meat and milk, but also wool. As a livestock industry, sheep breeding ranks third in the world. According to the latest data, the world population of these animals is about 1.2 billion heads.

The countries of the subtropical and tropical zones, which have large grazing areas, are engaged in the breeding of these animals. Desert and semi-desert areas are also suitable for sheep breeding. Therefore, the geography of the industry is extremely wide and diverse. Modern countries, leaders in the number of sheep are China, Australia, India, Great Britain, New Zealand, Sudan. This industry is also popular in Russia, Turkey, Spain, Morocco, Brazil and some other countries (Gaynutdinov et al., 2021).

Fine-wool sheep breeding is developed in countries with arid climates, with a large number of steppe and semi-steppe pastures, semi-fine wool meat-wool - in areas of sufficient moisture, with a milder climate, semi-coarse-wool and coarse-wool meat-greasy - mainly in deserts and semi-deserts.

In terms of wool production, China is the first in the world, Australia is second, and New Zealand is third, where almost all sheep breeding is represented by meat-wool semi-fine fleece breeds and the highest quality cross-bred wool is produced (Jian et al., 2014).

In Argentina, semi-fine-wool sheep are bred, mainly English long-haired and crossbred, and in small numbers - fine-wool, in Uruguay - mostly crossbred, in the USA - sheep such as English short-haired, in South Africa - merino, imported from Australia.

In European countries, sheep breeding is mainly semi-fine-fleece (Great Britain, Ireland, Norway, Denmark, Bulgaria) and fine-fleece (France, Romania, Hungary) (Dmitrik, 2017).

In Afghanistan and the countries of South Africa, karakul breeding is developed.

In the Republic of Kalmykia, there are pedigree farms of fine-fleece sheep known in Russia and abroad, and sheep breeding for meat is also well developed (Pogodaev et al., 2017a). The quality of sheep breeding products of these sheep has not been studied enough, and research at the microstructural level is practically completely absent, although sheep breeding in this direction plays a decisive role in providing the population of certain regions with good quality lamb and can provide valuable raw materials for the fur-coat industry in the form of sheepskins, from which high-quality fur semi-finished products (Pogodaev et al., 2019). The issues of expanding the range of semi-finished fur products of a higher quality level must be addressed in conjunction with the problems of improving the quality of raw materials (Dmitrik et al., 2014).

The economic condition, national economic significance and prospects for the development of sheep breeding in our country directly depend on the meat productivity of sheep. In this regard, there is a great interest in its improvement based on the use of the available breed gene pool of meat breeds of sheep, the creation of new breeds, more productive, well adapted to the local natural and technological conditions of their breeding (Pogodaev et al., 2021). Therefore, it is necessary to improve the genetic resources of sheep with early maturity and high meat productivity. In this regard, the Dorper meat breed has gained its popularity.

In 2016, Dorper sheep 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.

The Dorper breed was developed in South Africa in the 30s of the twentieth century by crossing local Persian black-headed and fat-tailed sheep with Dorset Horn rams (Sergeeva, 2016).

The breed got its name as a result of a combination of the first syllables from the name of the parental breeds - dor was taken from dorset horns, and - lane, from the Persian black-headed sheep (Souza et al., 2013). These breeds are among the most meaty and the second most popular in South Africa and belong to the long-tailed species (Malhado et al., 2009).

The Dorper breed was bred to survive in the harsh arid climatic conditions of South Africa, while it had to meet the following requirements: to be unpretentious in feeding, keeping, gaining the required live weight with insufficient, unbalanced feeding and, if necessary, do without water for some time (Souza et al., 2016).

Dorper sheep belong to the hairless breed, that is, they have a very short, straight, smooth coat that does not need to be sheared (Pogodaev et al., 2017b). Due to the fact that animals have short wool, they do not need to be sheared, and this reduces labor costs for keeping the herd, facilitates caring for them and does not affect feeding, since sheared sheep feed much less (Amorim et al., 2019).

The skin is considered, perhaps, the best in all respects due to its incredible smoothness, the absence of all kinds of folds and wrinkles and very smooth wen, as well as a fairly dense structure and thickness. Such skins are used to produce expensive outerwear and accessories of the highest quality.

The Dorper breed has proven itself well in crossing with others, and the lambs already in the second generation inherited the positive qualities of their parents and a good growth rate.

In this regard, it is relevant to study the productivity and interior indicators of hybrid sheep obtained on the basis of the Dorper breed, using microstructural morphometric research methods.

The purpose of our research was to study the qualitative indicators of sheepskins and the histological structure of the skin of Kalmyk fat-tailed rams and crossbreeds obtained on the basis of crossing of Kalmyk fat-tailed ewes with Dorper rams.

2. Material and Research Methods

The material for the research was the wool and leather of six and eight month olds of the Kalmyk fat-tailed breed and crossbreeds (½ Kalmyk fat-tailed + ½ dorper).

Location. Research and production experiments were carried out at LLC "Agrofirma Aduchi" according to the scheme presented in Table 1.

For the first experiment, two groups of ewes of the Kalmyk fat-tailed breed were formed according to the principle of pairs of analogues (Pizhurin, 2015), 40 heads each. The ewes of the first group were covered with rams of the Kalmyk fat-tailed breed, and the ewes of the second group were covered with rams of the Dorper breed (experimental group).

After lambing, the queen bees with lambs were kept for fattening on natural pastures. At four months of age, lambs were beaten from the queens. After beating, the young were kept in the pasture (feeding) up to 8 months of age.

For the second experiment, the same crossing was carried out, but 100 ewes were selected for each group.

After lambing for up to four months, the lambs were kept with queens on natural pastures. Then the lambs were beaten from the queens. After beating, two experimental groups of rams were formed, 22 heads in each, which were put to fattening. Fattening was carried out up to 6 months of age. At the end of the fattening, control slaughter of 3 rams from each group was carried out.

To study the commercial properties of sheepskins (Zavgorodnyaya et al., 2013) and the histostructure of the skin of rams in the process of slaughter, we determined the mass of the sheepskin and its area, and took samples of the skin on the right side of the animal (from three animals from each group), at a distance of the palm from the back and shoulder blade, in the place that serves to assess the quality of wool during grading (Dmitrik, 2013).

Table 1. Scheme of the experiment.

Group	Breed	
	ewes	rams
I-control	Kalmyk fat tail	Kalmyk fat tail
II - experienced	Kalmyk fat tail	dorper

Table 2. Hair length of experimental rams (Experiment # 1), cm (n = 20).

Index	Group	
	I - control	II – experienced
Wool length:	**M ± m**	**M ± m**
Side	12.50±0.23	9.08±0.29
Back	11.30±0.19	8.86±0.56
hip	12.80±0.19	9.44±0.36
belly	10.20±0.22	7.94±0.42

M: arithmetic mean; m: statistical error of the mean (standard error of the arithmetic mean).

Histological studies were carried out according to the generally accepted method in the laboratory of morphology and product quality of VNIIOK - a branch of the North Caucasian Federal Research Center of the Federal State Budgetary Scientific Institution.

The obtained experimental material was processed by the biometric method of variation statistics (Yakovenko, 2013).

3. Result and Discussion

According to the results of the first experiment, during a visual assessment of the wool samples of the experimental youngster, it was revealed that the wool is represented by thin braids, consisting of a thin awn, transitional fibers and fluff. The color of the coat is white.

Measurement of the length of the wool fiber showed that the length of the staple in all parameters of the body was greater in purebred rams of the Kalmyk fat-tailed breed, in contrast to the hybrid young by 3.42 cm (side), 2.44 cm (back), 3.36 cm (thigh), 2.26 cm (belly), or by 37.7%, 27.5%, 35.6%, 28.5% ($P > 0.999$), respectively (Table 2).

Numerous studies have proven that if the coat is shorter, then it is thicker and thinner (Dmitrik, 2013; Figueiredo et al., 2019; Li et al., 2020; Mirmahmoudi et al., 2017).

The diameter of the wool fiber is one of the most important features that determine the technological purpose. This indicator, to some extent, also determines the value of wool production of sheep and is closely related to the length, density and yield of pure wool.

In our studies, according to the staple length indicators, it can already be stated that the wool is thinner in crossbred animals (Table 3).

Coarser was the wool of the rams of the I group by 4.7 microns or 12.9%, in contrast to the peers of the II group. The control animals have 40 quality wool, and the experimental ones - 36, that is, the wool of hybrid young animals is thinner by two whole qualities, which is a very good indicator for the textile industry.

The fineness of the awn was thicker in purebred rams by 8.5%, the fineness of the transitional hair and down by 17.8%, in contrast to the hybrid young.

On the basis of the studies carried out, it can be concluded that in the crosses obtained from the crossing of Kalmyk fat-tailed ewes with Dorper rams, the length of the wool corresponds to the standards of technological parameters, it is thinner and thicker, in contrast to the chi-finned rams of the Kalmyk fat-tailed breed,

Table 3. The fineness of the wool of the experimental rams (Experiment No. 1), n = 20.

Group	Fineness of wool fibers, side, microns				
	average		including		
	µm	n	fluff	transitional hair	spine
	M ± m		M ± m	M ± m	M ± m
I - control	41.03±0.23	40	24.8±0.39	36.0±0.27	62.3±0.25
II - experienced	36.33±0.21	46	22.1±0.22	29.5±1.07	57.4±0.58

M: arithmetic mean; m: statistical error of the mean (standard error of the arithmetic mean); n: number of animals in the group.

in which the wool staple is longer, coarser and less frequent, which corresponds to the productivity parameters of coarse-wooled sheep.

Sheepskin is a single system of two main elements of leather and wool. In our studies, the parameters of sheepskins of hybrid young animals are presented in Table 4.

According to the results of the first experiment, the weight of paired sheepskins of young animals of group I had an advantage over their peers of group II by 1.0 kg or 34.5% (P> 0.999). In terms of the area of the paired sheepskin, the opposite picture is observed that the animals of the II group in this indicator exceeded their peers of the I group - by 7.36 dm2, or 8.0% (P> 0.99).

A large area of skin in the second group of young animals was influenced by a large live weight, and a smaller weight of sheepskin was influenced by the length of wool in the experimental group, which turned out to be shorter.

A similar picture was observed in the second experiment. So in terms of the mass of sheepskins, hybrid rams were inferior to purebred peers by 0.47 kg, and the area of sheepskins, on the contrary, was larger in crosses by 11.20 dm^2.

In the study of histological parameters of the skin revealed (Table 5) that the sheep of the I group, the skin is 352.57 μm thicker (14.52%) in comparison with the peers in the II group. In this case, the thickness of the layers of the total thickness of the skin in animals of group I is: epidermis - 0.8%, pilar - 69.8%, reticular - 29.4%; Group II - epidermis - 1.2%, pilar - 60.5%, reticular - 38.3%. The thickness of the epidermis affects the strength of the sheepskin. The densest epidermis was found in crossbred young animals of group II. Their superiority in this indicator over their peers in the control group was 6.12 microns or 27.7%. This is due to the fact that in animals of the meat direction, the epidermal part (flesh) is thicker.

Table 4. Parameters of the sheepskin of the experimental rams (n = 3).

Groups	Biometric indicator	Live weight	Sheepskin parameters	
			Weight sheepskin, kg	Area sheepskin, dm^2
		Experience №1		
I - control	M±m	39.44±0.26	3.90±0.10	91.73±1.16
	σ	0.37	0.14	1.64
	Cv	0.94	3.72	1.79
II - experienced	M±m	45.47±0.64	2.90±0.05	99.09±0.11
	σ	0.90	0.07	0.15
	Cv	1.98	2.50	0.16
		Experience №2		
I - control	M±m	40.43±0.43	4.10±0.21	93.71±4.85
	σ	0.75	0.36	8.40
	Cv	1.86	8.79	8.96
II - experienced	M±m	51.50±0.47	3.63±0.34	104.91±8.51
	σ	0.82	0.59	14.75
	Cv	1.59	16.13	14.06

M: arithmetic mean; m: statistical error of the mean (standard error of the arithmetic mean); σ: sample standard deviation; CV: coefficient of variation is a way of measuring the degree to which values in a set of data vary relative to the mean.

Table 5. Histological structure of the skin of experimental rams (experiment No. 1), n = 3.

Indicators	Group					
	I - control			II – experienced		
	M ± m	σ	Cv	M ± m	σ	Cv
Total skin thickness, microns	2780.44 ±78.84	136.55	4.91	2427.87 ±108.97	231.52	9.54
including epidermis	22.12 ±1.22	2.12	9.58	28.24 ±2.48	4.29	15.20
Pilar	1940.22 ±52.13	90.28	4.65	1469.29 ±87.62	151.77	10.33
reticular	818.10 ±49.23	85.26	10.42	930.34 ±50.64	87.72	9.43
Pilar ratio	2.4 ±0.153	0.22	9.00	1.6 ±0.033	0.05	3.17

M: arithmetic mean; m: statistical error of the mean (standard error of the arithmetic mean); σ: sample standard deviation; CV: coefficient of variation is a way of measuring the degree to which values in a set of data vary relative to the mean.

The pilar layer was thicker in the rams of the control group by 470.93 µm or 35.05% than in the experimental group (P> 0.99).

An indicator of the strength of the skin is the ratio of the pilar and reticular layers, the smaller it is, the stronger the skin. In our experiment, the difference was 0.8 in favor of the hybrid rams of the second group.

Of no small importance is the reticular layer, the structure of which (that is, the thickness of the collagen fibers and the nature of their connection) determines the quality of the sheepskin. The study of the reticular layer of the ram skin made it possible to establish that the collagen bundles are located mainly horizontally. They intertwine with each other, forming oval cells, inside which transverse fibers are located (Figure 1).

This type is called normal ligature and indicates good durability of the leather. The reticular layer of hybrid young animals of the second group is better developed in comparison with animals of the first group by 13.7% and occupies 38.3% of the total skin thickness, and in group I - 29.4%, which is less by 8.9 abs. %.

In our studies, we took into account hereditary variability, which is of a genetic nature, therefore we tried to create identical optimal conditions for animals, for a more reliable manifestation of their genotype.

The results of our research showed that in crossbred animals the coefficient of variability in the total thickness of the skin was high and amounted to 9.54%, in the thickness of the epidermis - 15.20%, in the thickness of the pilar layer - 10.33%, which is higher compared to by animals of the Kalmyk fat-tailed breed, respectively by 4.63 abs.%, 5.62 abs.%, 5.68 abs.%. In terms of the thickness of the reticular layer, the difference between the groups was insignificant.

The data obtained indicate that the mixed animals of the second group have great opportunities for improving the quality characteristics of sheepskin on the basis of selection work.

The density of the coat is the leading characteristic that determines the quality of the sheepskin. The softest coat is found in black and white and white individuals. In crossbreeds of group II, wool is mainly white, which meets the requirements of the processing industry for the manufacture of high quality sheepskin coats.

The experimental crossbred young animals belong to the coarse-wool breeds of sheep and have a wool tone on average of 36.3 microns, that is, quality 46, and in the control animals it is 41.0 microns (40k). Based on the standard for the breeds of coarse wool sheep, the fineness values are consistent with and are within the standard data.

The study of leather samples, namely, the thickness of the leather tissue and its structure, as well as the thickness of the coat is used in the practice of sheepskin products (Table 6).

The studies of the histological structure of the skin showed that the total density of hair follicles is small, which corresponds to the parameters of coarse-wooled sheep breeds. For rams of the first group, this indicator was - 27.57 pcs. per mm2 of leather, which is 3.12% less than in the second group.

The most objective indicator of wool density is the ratio of secondary to primary follicles (HF / PF) (Figure 2). In crossbred rams of group II, this indicator was 10.47% higher than in peers in the control group.

Purebred animals of the first group had a higher coefficient of variability in the density of primary hair follicles by 1.29 abs%, and secondary follicles by 0.52 abs.%, In comparison with hybrid rams.

Also, in the animals of the second group, the indicator of variability was lower than that of the rams of the first group in terms of the WF / PF ratio and amounted to 5.63%. The results of the research give grounds to conclude that crossbred animals obtained on the basis of crossing of females of the Kalmyk fat-tailed breed with rams of the Dorper breed have the best indicators of the quality of sheepskin and the best histological structure of the skin.

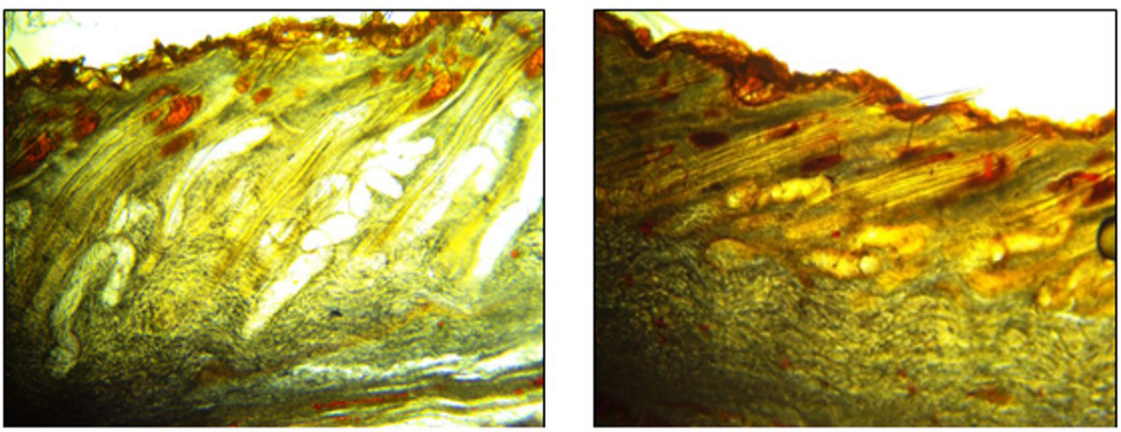

Figure 1. Histostructure of the skin of the experimental rams (Experiment No. 1) (thickness of the skin and its layers).

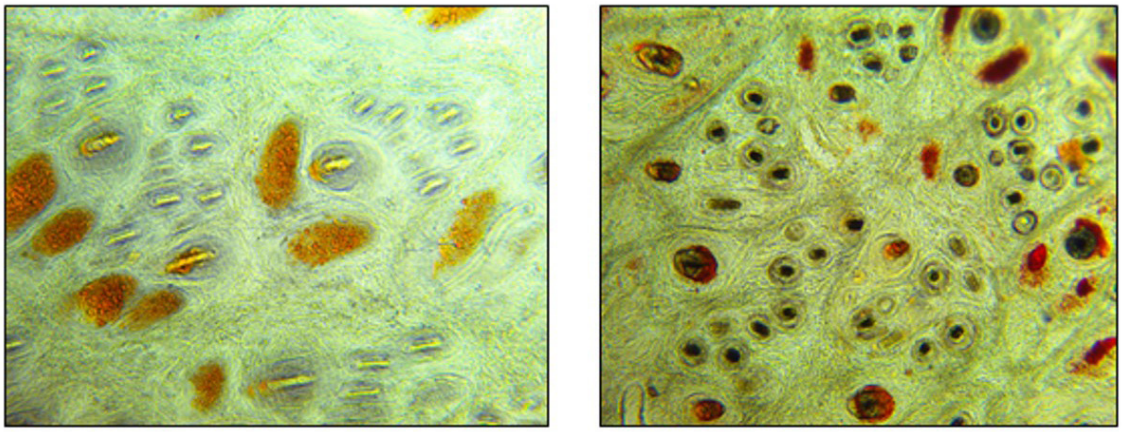

Figure 2. Horizontal histological section of ram skin (Experiment No. 1).

Table 6. Density of hair follicles in experimental rams after feeding (n = 3).

Group	Biometric indicator	Density of hair follicles, pcs. per mm2 of skin:			
		primary	secondary	Total density	Ratio change WF / PF
I	M±m	3.38±0.05	24.19±0.63	27.57±0.58	7.16±0.28
	σ	0.09	1.08	1.01	0.49
	Cv	2.73	4.48	3.67	6.83
II	M±m	3.19±0.03	25.24±0.58	28.43±0.53	7.91±0.26
	σ	0.05	0.1	0.92	0.44
	Cv	1.44	3.96	3.23	5.63

M: arithmetic mean; m: statistical error of the mean (standard error of the arithmetic mean); σ: sample standard deviation; CV: coefficient of variation is a way of measuring the degree to which values in a set of data vary relative to the mean; pcs: pieces; PF: primary follicles; WF: white follicles.

Table 7. Average weight and area of sheepskins of experimental rams after fattening (Experiment No. 2), (n = 3).

Indicators	Group	
	I	II
Pre-slaughter live weight, kg	39.44 ±0.26	45.47 ± 0.64
Sheepskin weight, kg	4.10±0.21	3.63±0.34
Sheepskin length, cm	114.33±7.31	110.00±3.79
Sheepskin width, cm	82.00±1.00	95.30±6.98
Sheepskin area, dm2	93.75±0.49	104.83±0.85

Crossbred animals have more elastic, firm and less thick skin by 14.52%, due to a greater thickness of the epidermis by 27.7% and a denser reticular layer by 13.7%. The wool cover (WF / PF ratio) in crossbred rams is 10.47% thicker in comparison with their peers, with a white color of wool, which corresponds to the technological requirements for the production of high-quality sheepskins.

In the second experiment, we also studied the histological parameters of the ramps' skin.

Sheepskins are a single system of two main elements - leather and wool. The physical and mechanical properties of sheepskins include such indicators as the area of the skin, its mass, thickness, wool, density and strength.

The study of the commercial properties of sheepskins and the histological structure of the skin of experimental young animals after fattening (Experiment No. 2) showed that the mass of paired sheepskins in hybrid young animals was 11.5% less than in the control group of rams, which is explained by the thinner and shorter hair in the experimental animals. groups (Table 7).

However, in terms of the area of sheepskins, the hybrid rams of the 2nd group had an advantage of 11.08 dm2, or 11.8%, compared with their peers in the 1st group. This difference is due to the higher fattening qualities of crossbred young animals, in which the length of the sheepskin is shorter and the width is greater, which is explained by the compact constitution of animals after fattening.

An essential indicator of the quality of sheepskin is the histological structure of the skin tissue itself, and especially of the reticular layer. In contrast to the pilar layer, the reticular layer has a uniform ligature of more powerful bundles of collagen fibers and therefore is the most durable and dense layer of the dermis. To study the structure of the

skin of uncut sheepskins, the total thickness of the skin and its individual layers was measured on histological preparations under a microscope. The research results are shown in Table 8 and Figure 3.

The thickness of skin layers in its total thickness in the 1st group of young animals was distributed as follows: epidermis - 0.99%, pilar layer - 72.46, reticular layer - 26.55; in the 2nd group - 0.84, 74.07, 25.09%, respectively.

The rams of the 1st group have a thicker layer of the epidermis (by 9.1%), a slightly larger reticular layer (by 6.9%) and a greater overall index of skin thickness (by 10.7%) in comparison with 2 -th group of young animals, which, in turn, has a more developed pilar layer (by 11.3%).

The presented studies of the histology of the skin of 6-month-old rams showed that the control group of animals had a more developed epidermis, reticular layer and general skin thickness, which is characteristic of coarse-wooled sheep breeds.

In the experimental group of young animals, the pilar layer is more developed, which is typical for animals with semi-thin and thin assortments of wool, and the reticular layer, the smaller the size, the denser, that is, the collagen fibers in this layer have a dense knit, which is positive affects the strength of leather and finished products from it.

Of no small importance is the wool density indicator, which determines the quality of the dressed sheepskin, and ultimately the finished product.

The research results showed (Table 9, Figure 4) that the total density of hair follicles in hybrid rams compared to peers in the control group was 3.3% more, and the density index - the HF / PF ratio - by 12.7%.

Fineness studies have shown that the rams of the 1st group have 44th quality wool (39.65 microns), it has fluff, transitional hair, awn, that is, coarse, and the hybrids of the 2nd group have 56th quality (29, 25 microns), ie, semi-thin, therefore, products from this sheepskin with a softer pile will also have a higher cost.

The crossbred young animals obtained from the queens of the Kalmyk breed and the Dorper rams surpass the purebred peers of the Kalmyk fat-tailed breed in terms of the area of the paired sheepskin and the indicator of the density of the wool base of the sheepskin.

Table 8. Skin thickness of experimental rams (Experiment No. 2).

Group	Layer thickness, microns			
	epidermis	pilar	reticular	general
I	26.61±2.01	1949.44±12.95	714.32±92.53	2690.37±80.16
II	22.34±1.12	1971.57±120.28	667.87±44.94	2661.78±159.91

Table 9. Density of sheepskin wool of experimental rams (Experiment No. 2).

Group Ram	Density per 1 mm2 of leather			
	PF (primary follicles)	SF (secondary follicles)	general	overall ratio SF / PF
I	3.71±0.26	26.24±0.70	29.95±0.52	7.07±0.63
II	3.43±0.13	27.50±2.57	30.93±2.70	7.97±0.43

PF: primary follicles; SF: secondary follicles.

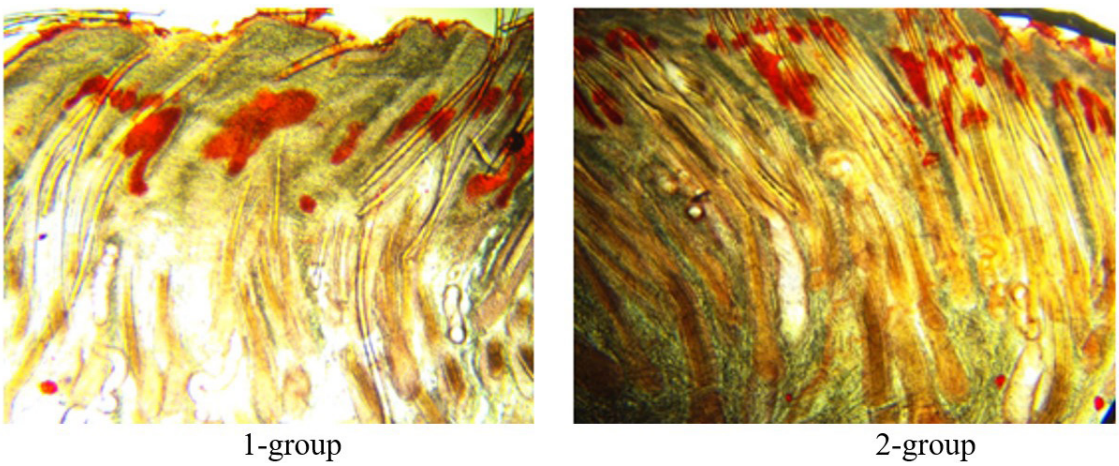

Figure 3. The thickness of the skin layers of the experimental rams (Experiment No. 2).

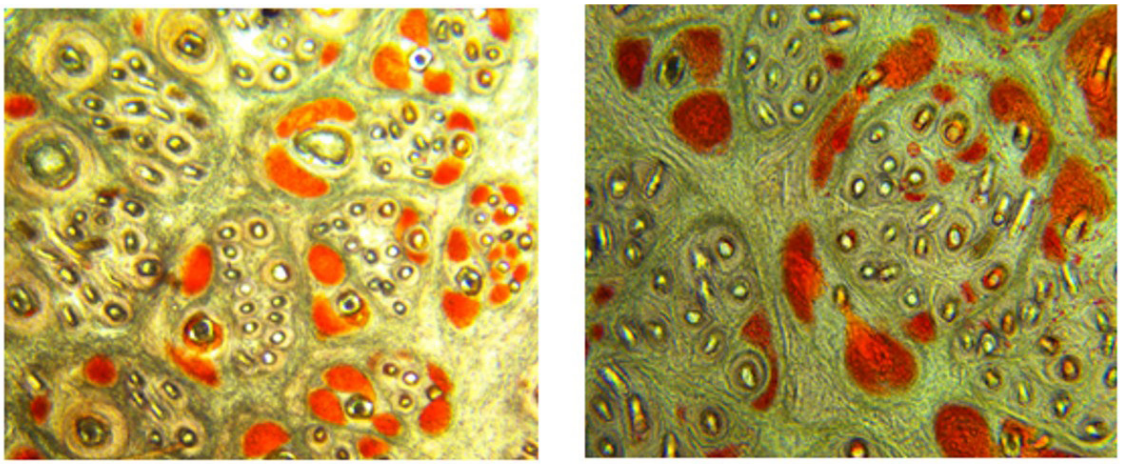

Figure 4. Density of hair follicles of rams (Experiment No. 2).

The crossbred young have stronger and more elastic sheepskins as a result of the compactness of the reticular layer - a dense interlacing of collagen fibers, with an area exceeding the norm of 104.83 dm2, which are first-class raw materials for the industrial production of fur products.

4. Conclusion

The studies carried out give grounds to conclude that the wool of cross-breed sheep (1/2 Kalmyk fat-tailed sheep × 1/2 Dorper) is thinner, thicker and in fineness can be attributed to a half-thin, in contrast to purebred Kalmyk fat-tailed sheep, in which wool staple is longer, coarser and less frequent, which corresponds to the productivity parameters of coarse-wool sheep.

Crossbred rams have a larger area of sheepskins, the skin is more elastic, durable and less thick, such sheepskins are first-class raw materials for the industrial production of fur products. The density of the coat (WF / PF ratio) in crossbred rams is greater than in purebred peers.

The creation of a highly productive type of beef sheep will increase the productivity of animals and the profitability of the sheep breeding industry.

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