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Original Article

Enhancement of the Reliability of Animal Genotyping Regarding the Betterment of Wool Productivity in South-Kazakh Merino Sheep in Kazakhstan

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Abstract

Enhancement of the production and productivity in animals is possible by improving the environment and changing the genetic structure of the herd which is done through selection. The present study aimed to investigate the efficiency of using genetic resources in the population of South-Kazakh merino sheep breed to improve and enhance the quality of wool productivity by determining a combination of phenotypic traits, morphobic and chemical parameters, as well as immunogenetic factors. Wool productivity was studied and accounted for by cutting each animal's wool during the period of shearing with an accuracy of 0.1 kg. At the age of 14 months, samples of wool were taken from 10 ewes of each group to study the yield of pure wool using physical and technological indicators. The value of reproducibility coefficients was determined by conducting correlation analysis. The value was estimated from 0.439 to 0.871 and 0.331 to 0.776 for the live weight and wool cutting, respectively. The number of woolens per 1 mm^2 of skin positively correlated with pure wool cutting (0.276±0.135) and woolliness factor (0.293±0.134), while it negatively correlated with the live weight of sheep (-0.055±0.140), staple length (-0.146±0.139), and toner wool (-0.180±0.138). This negative correlation implies that the most densely woolly sheep will not necessarily have a breeding advantage for the herd improvement on a combination of signs. However, the outstanding wool density as a separate indicator of sheep woolen productivity has a great breeding advantage; therefore, in the merino population, it is necessary to create a small factory line of sheep with a very large wool density. A variety of sheep productivity indices in each age had a high correlation with a variety of maximum productivity levels of animals bred in the conditions of "Batay-Shu" LLP.

Keywords: Fiber yield, Homeostatic system, Staple length, Wool

1. Introduction

A growing increase in demand for food will be one of the world's biggest agricultural challenges (1, 2). Environmental issues, such as climate change, changes in the exploitation systems, as well as shortage of water and energy crisis, have all affected the sheep industry productivity (3). Any solution that leads to increased productivity and reduced pressure on natural resources will help the agricultural community. Enhancement of production and maximizing profits is the primary goal of livestock breeding. To achieve this goal, proper planning and focused attention are required in order to sustain and develop the country's livestock, such as sheep, goats, cattle, and poultry (4). The main breeding strategies are inbreeding, interbreeding, and molecular genetics technology which is a practical mechanism for choosing among races (5-7). The efficiency and competitiveness of the sheep breeding industry at the current stage of the agricultural sector in Kazakhstan economy, resulting from a number of factors, including breeding improvement, rational use of genetic resources of domestic and world gene pool, taking into account biological characteristics, and the adaptive capacity of sheep in their breeding zone (8).

Enhancement of the productivity of farm animals is a central concern in genetics and animal breeding, which requires comprehensive knowledge of the structure and functions of genes, especially those, on which specific economically useful features depend (9-11). When genetic diversity in the races of a region is low, and genetic differences among races are not significant, it is necessary to change the average economic traits in a short period of time according to market needs; therefore, a selection strategy is needed (12, 13). In implementing this strategy, the interaction between genotype and environment is of prominent importance (14, 15). In fact, intra-racial selection involves predicting the breeding value and selecting superior sheep as the parents of the next generation (16).

Much progress has been made in the field of molecular genetics and biotechnology, which has provided powerful and new tools for the genetic modification of animals (17). One of the most useful tools is the use of genetic markers (i.e., DNA sequences) which creates differences among individuals, as well as within and between populations (18, 19). The use of markers has increased the accuracy and speed in determining the value of animal husbandry with low heredity and measuring the genetic value of traits that are very difficult to measure, such as sex restriction traits and traits that do not occur early in life (20). The application of genetic methods of research will allow the estimation of productive qualities of Russian breed sheep right after birth. Therefore, the efficiency of selection work in sheep breeding farms will increase. Knowing the genes structure peculiarities, which influence animal productivity, makes it possible to use them as genetic markers. Therefore, the carrier of those allele variants of the genes which are connected with high indices of received production of animal industries can be fixed in breed (9, 21-23).

The main purpose of the present study was to scientifically justify the expediency of using genetic resources in the population of South-Kazakh merino sheep breed in order to improve and enhance the quality of wool productivity by determining a combination of phenotypic traits, morphobic and chemical parameters, and immunogenetic factors.

2. Materials and Methods

The South Kazakhstan Merino Sheep is the quite productive thin-wooled sheep breed. The experimental phase of the current study was carried out in "Batay Shu" LLP, Shu district, the Zhambyl region, from 2016 to 2019. Wool productivity was studied and accounted for by cutting each animal's wool during the period of shearing with an accuracy of 0.1 kg. At the age of 14 months, the samples of wool were taken from 10 ewes from each group to study the yield of pure wool using physical and technological indicators (e.g., length and tone).

The yield of pure fiber, expressed in percentage, was established by washing 20 g of wool samples (10 g from the side, 10 g from the back). Afterward, the pure wool dressing was calculated taking into account the original wool dressing and the yield of pure fiber of 50 uteruses, rams-producers, and offsprings of different genotypes. Blood parameters were also evaluated based on the methodology in Islamov, Kulmanova (24). The results were presented in table 1 in our previous study.

3. Results

The findings of this study that was conducted at Batay-Shu LLP on the breeding stock of sheep represented by the South-Kazakh merino breed animals of an elite class are presented in this section. Since the animals were selected on the principle of analogues, there were no significant differences in the productive qualities of the sheep. At the same time, the number of the sheep in groups was approximately equal, which corresponds to the endurance of experimental studies, and genetic was the basis for improving the selection of South Caucasian merinos. The animal organism is a dynamically stable homeostatic system where all features of morphological and functional character with adaptive or productive values are connected by multilateral dependencies of organic integrity (9).

The correlative variability of blood and productivity indices of South Caucasian merino sheep was studied on 1.5-year-old lambs. Productivity indices of the sheep were determined for six features, and blood was taken to study hematological indices for 14 features. The results of the average level of development and the indicators of the variability of the indices are presented in table 1.

As can be observed in table 1, the productivity of experimental lambs was quite high, and blood parameters were within the physiological norms. Nevertheless, the comparatively high coefficients of variability of acidic blood capacity, globulin content, aldolase activity, alkaline, and acid phosphatase should be noted. A similar pattern with respect to the variation of interior and biochemical characteristics has been observed in previous studies of sheep and other animal species (8, 25, 26). The correlative variability of blood parameters and productivity of 1.5-year-old lambs is poorly expressed (Table 2).

It is worth mentioning that there are only some moderate trends in the sign. Therefore, in general, the difference between the frequency of positive (55%) and negative (45%) correlation coefficients is statistically unreliable. However, a noticeable peculiarity has been revealed in the process of directing the correlation of each blood characteristic with all sheep productivity indices. Peroxidase, leukocytes, alkaline, and acid phosphatase revealed a reliable prevalence (about 80%) of positive correlation coefficients. The frequency of negative correlation coefficients prevails (about 80%) in the correlation complexes of hemoglobin, albumin, globulin, and catalase activity. However, there was no significant difference between the positive and negative correlation frequencies regarding the other blood parameters.

Dressing of unwashed wool is significantly correlated with aldolase and catalase activity, while dressing of pure fiber correlates with aldolase activity and the total serum protein content in the blood. The length of the staple also reliably correlates with two out of 14 blood parameters, namely, the content of albumins and globulins in the blood serum of experimental animals (27-30). There are many histological features of the skin, which in one form or another are related to the processes of wool formation in sheep. However, only the density of hair follicles, the ratio of secondary follicles to primary follicles, and sebaceous and sweat glands have a direct impact on the sheep coat formation.

The results of analyzing some of these important histological skin structures and peculiarities of the sheep's wool cover in "Batay-Shu" LLP are given in table 3.

Table 1. Blood productivity and indices of 1.5-year-old lamb cubs from Islamov, Kulmanova (24)

Symbol	**N**	**X±mx**		**Cv**
Dressing of unwashed wool, kg	50	6.81±0.053	0.81	12.1
Staple length, mm	50	9.36±0.059	0.90	9.6
Live weight, kg	50	54.0±2.784	4.26	7.9
Pure fiber output, %	50	39.5±0.390	5.07	12.9
Slicing of pure fiber, kg	50	2.68±0.034	0.44	16.4
Coefficient of woolliness, d	50	57.0±0.823	10.7	18.8
Erythrocytes, million in 1 mm^3	50	8.99±0.048	0.66	7.4
Leukocytes, thousand in 1 mm^3	50	6.90±0.138	1.74	25.9
Hemoglobin, g%	50	8.85±0.174	2.48	27.9
Catalase, mg H_2O	50	2.16±0.039	0.55	25.9
Peroxidase	50	37.5±0.379	5.36	14.3
Acid capacity, mg%	50	35.6±11,39	1.61	45.2
Acid phosphatase, BE	50	1.01±0.030	0.40	39.8
Alkaline phosphatase, CU	50	9.29±0.368	4.98	53.7
Aspartate transaminase, 1 mm^3 unit	50	50.9±0.412	5.44	10.7
Alanine transaminase, 1 mm^3	50	28.4±0,171	2.23	7.8
Aldolase, uh...	50	2.73±0.125	1.43	52.4
Albumins, d	50	4.84±0.106	1.33	27.6
Globulins, d	50	2.04±0.089	1.11	54.5
Total protein, g%	50	6.88±0.046	0.58	8.4

Table 2. Correlative variability of blood parameters and productivity of 1.5-year-old lambs (N=50)

Blood Indicators	Parameters	length	Live weight	Trim of the mute wools	Pure wool yield	Clean wool trigger	Coefficient of woolliness
Erythrocytes	r	-0.066	-0.016	+0.095	-0.015	-0.028	+0.034
	mr	±0.073	±0.073	±0.073	±0.086	±0.086	±0.086
Leukocytes	r	+0.0137	+0.0116	-0.015	+0.009	+0.024	+0.069
	mr	±0.079	±0.080	±0.080	±0.091	±0.091	±0.091
Hemoglobin	r	-0.054	-0.008	+0.031	-0.047	-0.079	-0.090
	mr	±0.070	±0.070	±0.070	±0.082	±0.082	±0.082
Catalase	r	-0.068	-0.071	-0.154	-0.055	-0.062	+0.010
	mr	±0.071	±0.071	±0.071	±0.083	±0.083	±0.083
Peroxidase	r	+0.039	+0.105	+0.098	-0.41	+0.034	+0.016
	mr	±0.071	±0.071	±0.071	±0.082	±0.082	±0.082
Acidic capacitance	r	-0.102	-0.074	+0.001	+0.025	+0.081	+0.062
	mr	±0.071	±0.071	±0.071	±0.081	±0.081	±0.081
Acid phosphatase	r	+0.003	-0.102	+0.069	+0.020	+0.028	+0.086
	mr	±0.075	±0.075	±0.075	±0.089	±0.089	±0.089
Alkaline phosphatase	r	+0.098	+0.107	+0.131	+0.041	+0.134	+0.047
	mr	±0.074	±0.074	±0.071	±0.090	±0.089	±0.090
Aspartate transaminase	r	+0.020	-0.133	-0.024	+0.054	+0.073	+0.053
	mr	±0.076	±0.076	±0.076	±0.093	±0.093	±0.093
Alanine transaminase	r	+0.012	+0.057	+0.114	-0.029	-0.052	-0.038
	mr	±0.077	±0.077	±0.077	±0.094	±0.094	±0.094
Aldolase	r	+0.012	-0.066	-0.179	-0.159	-0.251	-0.140
	mr	±0.088	±0.088	±0.088	±0.108	±0.107	±0.108
Albumins	r	-0.162	+0.033	+0.082	+0.013	+0.007	-0.044
	mr	±0.080	±0.080	±0.080	±0.096	±0.096	±0.096
Globulins	r	+0.163	-0.095	-0.003	-0.060	-0.087	-0.075
	mr	±0.080	±0.080	±0.080	±0.095	±0.095	±0.095
Total protein	r	-0.040	-0.107	+0.148	+0.103	+0.217	+0.094
	mr	±0.080	±0.080	±0.080	±0.095	±0.095	±0.095

Table 3. Indicators of woolen skin structures and sheep's wool cover

Group of sheep	N	X±m	Cv	Lim
Number of woolen areas per 1 mm^2 of skin				
Manufacturers of rams	30	71.2±1.31	10.0	57-89
Ewes	50	58.0±0.74	9.1	48-70
Young ewe (15 months)	80	60.5±0.87	12.9	43-80
Ratio of secondary follicles to primary follicles				
Manufacturers of rams	30	15.7±0.44	15.3	11-23
Ewes	50	14.1±0.22	11.4	10-18
Young ewe (15 months)	80	14.4±0.31	19.3	10-20
Tonino wool, μm				
Manufacturers of rams	30	23.6±0.43	10.1	19.1-28.4
Ewes	50	22.3±0.22	7.0	18.0-27.0
Young ewe (15 months)	80	18.8±0.23	11.1	14.9-23.0
Wool fortress, km				
Manufacturers of rams	30	11.2±0.22	10.6	9.7-14.7
Ewes	50	9.79±0.12	8.9	7.3-11.7
Young ewe (15 months)	80	9.65±0.08	7.6	6.9-12.7
Fat content of pure nonfat wool, %				
Manufacturers of rams	30	34.9±1.81	28.5	17.7-53.3
Young ewe (15 months)	80	17.4±0.68	34.7	8.0-41.3

In addition to this indicator for the group of young ewes, the fat content of wool is calculated by two other methods, namely the ratio of wool fat mass to the permanent dry mass of non-fat wool and the ratio of the permanent dry mass of unwashed wool (Table 4).

Despite being more informative, the last two indicators are not yet widely available. However, it is possible to notice that according to some foreign data, the fat content in the permanent dry unwashed wool of Australian merinos fluctuates from 10% to 25.4% and reaches an average of 16.1%, which is considerably higher than that in the South Kazakhstan merino sheep. The results of analyzing the correlative variability of the sheep's wool density at "Batai-Shu" LLP are given in table 5.

Similar regularities of the correlated variability of wool density are also noted for other breeds. Data on the relative tonnage variability of the sheep's wool of South Kazakhstan merinos of "Batai-Shu" LLP are given in table 6.

At the present stage of sheep breed selection among South Kazakh merinos, along with purebred breeding, there was an urgent need to apply industrial crossing to increase the production of lamb and woolen productivity. The amount of wool cut from a sheep depends on the constitutional features of the animal, breed, gender, age, size of the animal, density of wool, its length, thickness, as well as feeding and husbandry conditions. The need for the development of fine-wool sheep breeding necessitates the improvement of wool quality, cutting of pure wool, toning, and equation. Variability of the wool cutting of posterity (young ewes) received from experimental animals is shown in table 7. On average, there is 5.07 kg of wool cut from experimental animals. The largest wool cutting was obtained from the SKM×SKM young ewe, which outnumbers its counterparts from AM×SKM by 0.34 kg or 7.0% (P>0.99). In the output of the washed wool, bright colors from SKM×SKM also surpass peers from AM×SKM by 2.5%. The lowest pure cut (2.99 kg) was obtained from AM×SKM young ewe.

Table 4. Characteristics of the young ewe wool cover (N=160)

Symbol	X±m		Cv	Lim
The percentage of fat in the permanent dry weight of pure nonfat wool	19.3±0.40	4.98	25.8	8.8-34.3
The percentage of fat in the permanent dry mass of pure wool	24.6±0.61	7.74	31.5	9.7-52.3
The percentage of fat in the permanent dry weight of unwashed wool	9.7±0.19	2.40	24.7	4.8-16.3
The percentage of impurities in the permanent dry weight of unwashed wool	49.4±0.51	6.36	12.9	28.0-67.7
Wool length when boning, cm	9.39±0.07	0.79	8.4	7.0-11.0
The length of the cut staple, cm	8.45±0.08	0.97	11.5	6.0-10.5
The length of the outermost dirty staple area, cm	4.54±0.06	0.73	16.1	3.0-7.0
The percentage of the external staple contamination	54.2±0.72	9.09	16.8	35.3-78.6
The length of the internal staple contamination zone, cm	3.00±0.06	0.73	24.3	1.0-6.0
Number of scrolls per 1 cm staple length	7.14±0.11	1.32	18.5	3-10
Well-expressed apology, %	6.9	-	-	-
Well-expressed curvature, %	17.6	-	-	-
Satisfactory apology, %	25.8	-	-	-
Poorly-expressed curvature, %	37.1	-	-	-
Washed character of wriggle, %	12.6	-	-	-

Table 5. Correlative variability in the sheep's wool density

Characteristics	Manufacturers of rams (N=30)	Ewes (N=50)	Young ewe (N=80)
Live weight	-0.307±0.178	+0.157±0.142	-0.016±0.113
Dressing of unwashed wool	-0.412±0.172	+0.576±0.118	+0.065±0.113
Staple length	-0.308±0.178	-0.119±0.143	-0.011±0.113
Dressing of pure wool	+0.121±0.187	+0.598±0.116	+0.109±0.112
Coefficient of woolliness	+0.319±0.153	+0.448±0.127	+0.112±0.112
Percentage of fat in pure nonfat wool	+0.027±0.188	-	-0.040±0.113
Tonino wool	-0.296±0.180	-0.056±0.144	-0.188±0.111

Table 6. Correlative variability in the sheep's wool tonnage

Characteristics	Para-meter	Manufacturers of rams	Ewes	young ewe
N		50	100	100
Live weight	r	+0.142	+0.025	+0.072
	mr	±0.187	±0.145	±0.112
Dressing of unwashed wool	r	+0.030	+0.140	-0.107
	mr	±0.189	±0.142	±0.111
Staple length	r	-0.228	+0.106	-0.009
	mr	±0.185	±0.144	±0.113
Pure wool yield	r	+0.055	+0.078	+0.007
	mr	±0.188	±0.144	±0.113
Dressing of pure wool	r	+0.090	+0.155	+0.064
	mr	±0.188	±0.142	±0.112
Coefficient of woolliness	r	-0.015	+0.218	-0.086
	mr	±0.189	±0.141	±0.112
Wool fortress	r	+0.058	+0.384	+0.054
	mr	±0.188	±0.133	±0.113

Table 7. Variability of the wool cutting of the young ewes

Breed		N	Cutting wool, kg			Output of washed wool, %	Washed up, kg.	Woolliness coefficient, d
			Off the beaten track					
Father	Mother		X±m		Cv			
SKM	SKM	50	5.24±0.09	0.48	9.2	63.5	3.32	68.0
AM	SKM	50	4.90±0.07	0.46	9.3	61.0	2.99	62.2
On average		100	5.07±0.08	0.47	9.25	62.25	2.68	65.1

The average woolliness coefficient of the subjects under study was 65.1 g. higher than what was observed among the SKM×SKM test subjects (68.0 g). The woolliness coefficient of the South-Kazakh merino purebred young ewe was 5.8 g (P>0.99) higher than that of AM×SKM's peers. Tortuosity determines the natural and true length of the wool. Natural length is the length of a staple or braid in a twisted state, while the true length is the length of a bundle or individual fibers in a straightened but not stretched state.

The length of the wool is measured by a ruler in accordance with State Industry Standard 28491-90, the natural length of wool, awnings, and down is measured based on the height of not stretched staple (or plaits) on a barrel directly behind an average horizontal line of a blade. True length is determined using the FM-04 and others. Natural and true lengths are measured in centimeters or millimeters. The true length of a single fiber is always greater than its natural length, and the average true length of staple or plait fibers may be greater than, less than, or the same as their natural length, depending on the length of the fiber components. The natural length of wool is taken into account when boning sheep when evaluating wool according to the procurement and industrial standards, and the true length is taken into account in technology. The wool length depends on the type and variety of fibers, breed, gender, age, physiological condition, individual features of animals, feeding conditions, duration, and seasonal features of wool growth. Systematic selection of animals with a wool length not less than 8 cm contributed to the formation of South Kazakhstan merino breed with worsted wool length (Table 8).

The data presented in table 8 testify that the best length of wool on the main body parts was noted at the rams from the selection of AM×SKM, and the excess over the purebred rams of South Kazakhstan merino was 2.94% on the side and 3.37% on the back (P>0.95; 0.99).

The wool density is the density of woolen fibers on the surface of the skin. Thin-skinned sheep are the most densely woolen breed since they have up to 10,000 woolens per 1 cm^2 of skin area. Thick-skinned sheep have 700-1,000 woolens, and semi-thin-skinned sheep have 3,000-5,000 woolens. The density of wool is directly related to the cutting of wool in the washed form. For the external estimation of merino sheep, it is necessary to pay attention to the density of wool, which is defined by calculating the number of woolens growing on 1 cm^2. This method of determination is not used in practice since the wool thickness is mostly determined through visual or tactile inspection. The utilization of this practical method is possible after acquiring relevant experience. To a certain extent, the density is determined visually, based on the width of the skin stripes formed by the deployment of the sheep's hair down to the skin itself. The narrower the stripes, the thicker the coat, and vice versa. There are 29 to 88 hair strands per 1 mm^2.

Dense wool is characterized by a square outer and cylindrical inner staple through narrow zigzag skin seam and low dust penetration (20%-25% of the height of the staple). The densest wool is on the scapula, sides, and hips; however, the wool on the back is less dense, and there is rarely any wool on the belly. In our studies, the density of wool was determined by expert judgment (table 9).

The data in table 9 show that the density of wool on the barrel of rams in both groups had the index of dense wool (i.e., "M±"); however, more than half did not have the index of very thick wool "MM". In the group of young ewes, by selecting AM, the "M±" and "MM" indicators denote 30.7% and 65.8%, respectively. However, after selecting SKM×SKM, the "M±" and "MM" indicators signify 52.6% and 47.4%, respectively (i.e., the excess was 18.4%).

In everyday practice, the toning of wool is expressed in qualities. The value of quality is determined based on the number of young ewe skeins on the English spinning system (in one skein 512 m) of one pound (453.6 g) of pure wool. If 60 coils have been produced, the wool is of 60^{th} quality. This system for determining wool toning is called Bradford (by the name of the English city where it was developed). The direct diameter of the fibers is determined with the help of devices (Nanometer, microscope, OFDA-2000 express device for determining wool tint).

Table 8. Wool length of repair lambs depending on their origin

Breed		n	Wool length, X±m			
Father	Mother		Side	Cv	Back	Cv
SKM	SKM	50	9.86±0,3	15.3	9.50±0.5	12.47
AM	SKM	50	10.15±0.7	18.0	9.82±0.6	13.53
On average		100	10.00±0.6	16.7	9.66±0.5	13.00

Table 9. Heavy wool density in youngsters aged 12 months

Breed		Gender of the animal	N	Heavy wool, %		
Father	Mother			M	M±	MM
SKM×SKM		Rams	50	30.3±0.33	64.7±0.49	-
		Young ewe	50	3.5±0.5	52.6±0.36	47.4±0.51
AM×SKM		Rams	50	45.5±0.30	54.5±0.41	-
		Young ewe	50	-	30.7±0.38	65.8±0.45

The results of the expert determination of wool toning (Table 10) show that the 60th wool quality had rams from the selection of AM×SKM (83.6%) and SKM×SKM (73.5%), and in the group of young ewes from the selection of AM×SKM (5.5%) and SKM×SKM (5.8%). It should be noted that the rest had the wool of the 64th quality.

In practice, it is divided into 2 to 3 types according to the degree of "fusibility", which implies the solubility of fat (washability from wool) by warm soapy solutions since this is how fat is removed from wool in the factory processing. The qualitative characteristic of fat loss is obtained in the form of objective chemical indicators of wool fat (e.g., the iodine number, the relative content of mainly oleic, less frequently linoleic, and other unsaturated fatty acids in wool fat). The acid number characterizes the free acid content of wool fat. The saponification number indicates the average molecular weight of bound and free fatty acids. The etheric number indicates the content of esters in wool fat. Melting point characterizes the resistance, and therefore, the preservation of wool fat composition in the case of environmental temperature changes. In addition to water, sweat composition includes various organic compounds and minerals, mainly potassium and sodium salts. Wool fat consists of complex fat-like compounds, mainly related to the cholesterol group. Fat has an alkaline reaction, and wool fat is acidic. This indicates that the interaction of sweat and fat is a chemical process with partial washing of wool fat. The amount of woolen fat in fat loss varies from 10% to 52% and more, depending on the weight of pure skimmed wool, breed, gender and individual characteristics of the sheep. Merino wool sheep have the highest wool fat content. Excessive fat loss in wool is also undesirable since the yield of pure wool is reduced, and most importantly, feed nutrients are used to create fat loss, and sheep producing large amounts of fat loss are less valuable for their constitutional characteristics in terms of good feed payment and the development of meat productivity. The technical use of grease consists mainly of soap used to wash wool, potash, lubricating oils, lanolin, and fertilizers. Lanolin is widely used in cosmetics and medicine both as a standalone product and a good basis for making various ointments. For the sharply continental climate of the Zhambyl region with very hot summers, when the air temperature in the sun often reaches 50-60°C, the quality and quantity of fat is of great importance.

Along with other factors (e.g., the density of wool and state of a staple), Giro pot contributes to the preservation of the physical and chemical properties of wool. In the South Caucasian merino wool, different amounts of fat are observed depending on gender, age, feeding conditions, content, and selection options (Table 11).

The data in table 11 show that lamb heads obtained from the selection of SKM×SKM and AM×SKM mainly have a white color of grease (76.3%-86.1%), and young ewe color from the selection of AM×SKM is 72.7%; however, 23.7% and 27.3% had the light cream color of grease. Nonetheless, the purebred vividness from the selection of the SKM×SKM mostly had light cream color (82.9%). It is important to emphasize that the complex physical properties, namely length, curvature, toning, fat content, the yield of pure fiber, and some other indicators of the South Caucasian merino wool, belong to the merino wool.

Since 2000, research has been conducted in LLP "Batay-Shu" for determining the perspiration yield of washed wool. Table 12 shows the results obtained from 2016 to 2019 regarding the group of sheep and wool classes received from different selection options. To determine the output of the washed wool, 200 g samples were taken from each one of 20 runs in each class. Squeezing of washed wool was carried out on the hydraulic apparatus "CS-53". As can be observed, rams and young ewes, received from different selection options, had different high yields of washed wool. On the group of rams, this figure ranges from 50.4% to 52.6%; however, it ranges from 51.9% to 52.5%.

At the same time, the greatest yield of pure wool is characterized by the offspring from the selection of AM×SKM. It should also be noted that the high yield of pure wool is obtained from young ewes in comparison with rams in both variants of selection.

Table 10. Tonino wool of youngsters according to the boot data

Breed		Gender of the animal	N	Wool tint in qualities	
Father	Mother			60th	64th
SKM	SKM	Rams	50	73.5±0.49	26.5±0.27
		Young ewe	50	5.8±0.10	94.2±0.81
AM	SKM	Rams	50	83.6±0.63	16.4±0.31
		Young ewe	50	5.5±0.19	94.5±0.85

Table 11. Color of fatty youngsters according to bonus data

Breed		Gender of the animal	n	Grease color, %	
Father	Mother			White	Cream and light
SKM	SKM	Rams	50	76.3±0.49	23.7±0.29
		Young ewe	50	17.1±0.28	82.9±0.73
AM	SKM	Rams	50	86.1±0.57	13.9±0.25
		Young ewe	50	72.7±0.41	27.3±0.33

Table 12. Output of the washed wool

Breed		Gender of the animal	Including by class				
Father	Mother		On average	I	II	III	Lumpy
SKM	SKM	Rams	51.6	52.5	51.4	49.2	48.6
		Young ewes	53.1	54.3	53.0	50.8	49.5
AM	SKM	Rams	54.7	55.3	54.7	51.2	49.0
		Young ewes	54.9	55.3	54.4	50.8	49.7

4. Discussion

Due to the unification and improvement of wool quality assessment principles, instrumental measurements of sheep's wool cover should attend to features, such as wool fiber thickness, fat content in wool, wool fiber strength, and the percentage of mineral and vegetable impurities in wool.

As can be observed, the indices of wool density and the ratio of secondary follicles to primary ones in South-Kazakhstani fine-fleece sheep of "Batai-Shu" LLP is rather high, which corresponds to the level of indices related to the factory animals of leading fine-fleece sheep breeds in the Commonwealth of Independent States countries. The sheep's wool is slightly thin, especially the young ewe. It has also determined to some extent the specificity of wool curvature, which is numerous small curls. Due to the fact that the curves are small and not always sufficiently uniform, the sharpness of the overall curvature of the staple has deteriorated. Indicators of how strong the wool of the experimental flock of sheep is show that all the studied wool is strong. Fat content in pure nonfat wool of South Caucasian merino sheep is within the limits of this feature.

In most cases (i.e., 17 out of 20), correlation coefficients are statistically unreliable. The concerns are especially about rams manufacturers and young ewe, where no index of reliable correlated variability of features is obtained. The density of sheep's wool positively and statistically correlates with pure wool cutting, woolliness factor, and unwashed wool cutting. It should be noted that pure wool cutting and woolliness coefficients of ram producers and young ewe also positively correlate with wool density; however, this dependence is insignificant in size. For all groups of sheep, there is some tendency for the length and thickness of fibers to decrease as wool density increases.

Taking into account the value of the actually obtained correlation coefficients of wool toning with various indices of sheep productivity and considering the results of other studies, it can be concluded that increasing wool fiber thickness increases the shearing of pure and unwashed wool, the wooliness coefficient, the percentage of pure fiber yield, and the live weight of sheep (slightly); however, it practically does not change the length of the staple. Accordingly, the actual material in this subsection allows us to conclude that there is, in many cases, a significant correlation among the histological structures of the skin, the characteristics of the wool cover, and the productivity of the sheep, which is necessary for understanding the mechanisms of facilitating productive advantages of animals. However, for breeding purposes, even more important are the laws of correlative variability among direct selection traits that determine the economic value of sheep populations.

The results of the subjective evaluation have low repeatability. The histological method for determining wool density is more accurate; however, it is time-consuming. Recently, the weight-counting method has become widespread. The histological method, taking into account skin shrinkage, is the most objective and is used in all cases where accurate information about the density of wool is needed (e.g., individual assessment of rams and uteruses, experimental and other works). The score weighing method can be used to determine the average values of wool density in relation to the large groups of animals. It has been established that in merino sheep, the average wool density is 60 to 75 fibers, and in semi-fine and many coarse-wooled breeds, the corresponding numbers are 20-40 fibers per 1 mm^2 of the skin. The thickness of wool is estimated by experts using the following indirect indicators. First, in the area of the scapula, locks of wool are felt and the feeling of "full" bundles of wool is judged on its thickness. Subsequently, establishing the shape of the outer staple on the side of the sheep turns the wool and determines the shape of the inner staple, the width of the skin seam, and the depth of penetration into the staple of dust. In wool science, the thickness of wool fibers is commonly referred to as toning, which is considered the most important determinant of wool production. The exceptional value of toning among other properties of the fibers is explained by the dependence of the toning of young ewe, as well as the thickness and weight of woolen products on this feature. Accordingly, the finer the wool, the younger ewe and fabric are obtained from it. As a result, in all wool classifications, toning is the main and often the only systematic feature. The toning of wool is most often expressed by the average arithmetic transverse size of the fibers (in micrometers), the number-relative length of the wool to its weight, and the toning class quality (for homogeneous wool). Many authors have confirmed the wool of South Caucasian merinos in the basic mass which has the toning of 64 quality.

Homogeneity of wool and its toning are the determining signs when attributing sheep to this or that direction of productivity (thin-fiber, semi-fiber, semi-coarse, and coarse-wool). At the same time, wool toning largely determines the technological qualities of wool as a raw material for the textile industry.

The secrets secreted by the greasy and sweat glands on the surface of the skin are mixed and then entered into chemical reactions. The result is a new chemical compound called grease. Fat contributes to the protection of wool from harmful external physical, and chemical influences, and its better formation in dense bundles (staple, pigtails). The prevailing importance for the preservation of these valuable properties of fat loss is attached to wool fat, which has great variability due to breed and other individual characteristics of sheep.

The number of woolens per 1 mm^2 of skin positively correlates with pure wool cutting (on average: +0.276±0.135) and woolliness factor (on average: +0.293±0.134). On the other hand, it negatively correlates with the live weight of sheep (on average: -0.055±0.140), staple length (on average: -0.146±0.139), and toner wool (on the average: -0.180±0.138). This negative correlation gives the grounds to consider that the most densely-woolly sheep will not always have a breeding advantage at herd improvement on a complex of signs. However, the outstanding wool density as a separate indicator of the sheep's woolen productivity has a great breeding advantage; therefore, in the merino population, it is necessary to create a small factory line of sheep with a very large wool density.

Authors' Contribution

Study concept and design: E. I. I.
Acquisition of data: G. A. K
Analysis and interpretation of data: B. T. K.
Drafting of the manuscript: D. N. B.
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Statistical analysis: A. S. Z.
Administrative, technical, and material support: E. I. I. and G. A. K

Ethics

All the procedures were approved by the Ethics Committee at the Kazakh National Agrarian University, Almaty, Kazakhstan.

Conflict of Interest

The authors declare that they have no conflict of interest.

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