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Inheritance of the Fat Tail Parameters in the Rams and Ewes Offsprings with Different Sizes of the Fat Tail

Zhanibek A. Parzhanov[1]*, Nurzhan N. Azhimetov[1], Yermakhan I. Kistaubayev[1], Yerubay Baibekov[2] and Taubassar A. Mustiyar[2]

[1]Shymkent University, 426 Building, 225 Quarter, Karatau District, Shymkent, The Republic of Kazakhstan.
[2]Peoples Friendship University Named after Academician A. Kuatbekov, 32 Tole Bi Str., Shymkent, the Republic of Kazakhstan.

ABSTRACT

In Kazakhstan, special importance is attached to the development of meat and fat sheep breeding, the purpose of which is to increase the production of environmentally friendly lamb and mutton in transhumance. The problem of conservation and rational use of the pedigree gene pool of meat-and-fat sheep breeding is an important part of the program for the restoration and development of this industry in the country. One of the important tasks of meat-and-fat sheep breeding is the development of desert and semi-desert pastures to obtain competitive sheep products. The purpose of our research was to study the inheritance of fat tail parameter in the offspring of rams and ewes with different fat tail sizes. The work was carried out in the "Ortay" peasant farm of the Ordabasy district of the Turkestan region. It has been established that in the case of animals' selection (♂ small fat tail x ♀ large fat tail), the proportion of ewe hoggs and ram hoggs with a desirable small fat tail amounted to 27.6-29.2%, respectively, and lambs with a medium fat tail size of 24.4-20.1%, and with a large size of 48.0 and 50.7%, respectively. In the second selection option (♂ small fat tail x ♀ medium fat tail), lambs were obtained with a small fat tail by sex, respectively, 43.4-41.8%, with a medium size of 42.8 and 43.8%, with a large size of 13.8 and 14.4%.

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Authors' Contribution
ZAP prepared the research program and methodology and formation of experiments. NNA and ZAP drew the experiment scheme. YIK did collection and analysis of the data obtained. YB selected and analysed samples. NNA, ZAP, TAM and YB conducted experiment and research.

Key words
Meat and fat sheep breeding, Fat tailed breed of sheep, Fat tail, Growth and development of lambs, Ordabasy sheep

INTRODUCTION

The intensification of agricultural production, including sheep breeding, the growth in demand for the products of this industry in all countries of the world is accompanied by the creation of new, more productive breeds of sheep, the breeding of which is m`ore economically profitable. Breeds usually occupy a dominant position in modern sheep breeding, providing the production of large commercial batches of the same type of sheep products (Poczai and Santiago-Blay, 2022).

The diversity of genetic resources is the basis for the creation of new breeds, types, lines of animals with high productivity potential and good adaptability to local natural, economic and technological breeding conditions (Richardson *et al*., 2023). According to the FAO, the world gene pool includes more than 1300 breeds and intrabreed types of sheep, most of them created by centuries of natural selection and the work of many generations of livestock breeders, who have an outstanding adaptability to breeding in various natural and climatic conditions, the ability to meet the needs for various types of sheep products, often differ in the unique severity of such traits as fertility, polyestricity, precocity, milkiness, fur, ftir and other products (Romanov *et al*., 2021).

In the world, there is a relatively rapid increase in the number of fat-tailed breeds of sheep than fine-fleeced and semi-fine-fleeced breeds of sheep, and this trend, according to FAO, will continue in the coming years (Nonavar *et al*., 2023).

Great attention is paid to the preservation and expansion of the pedigree gene pool of sheep in many countries of the world. So, modern sheep breeding in Europe is represented by more than 300 breeds of sheep. In England, despite the presence of 60 breeds of sheep, much attention is paid to the creation of new, more productive

* Corresponding author: zhanibek_58@mail.ru
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breeds (Romanov *et al*., 2021).

In Kazakhstan, special importance is attached to the development of meat-and-fat sheep breeding, the purpose of which is to increase the production of environmentally friendly lamb and mutton in animal husbandry (Zhumadillayev *et al*., 2022). The problem of conservation and rational use of the pedigree gene pool of meat-and-fat sheep breeding is an important component of the program for the restoration and development of this industry in the country. One of the important tasks of meat-and-fat sheep breeding is the development of desert and semi-desert pastures to obtain competitive sheep products (Justinski *et al*., 2023).

The use of Hissar rams at the age of 1.5 and 2.5 years to the Yedilbay ewes significantly affects the slaughter and meat qualities of offspring at birth, weaning from ewes and at 16 months of age (Marzanov *et al*., 2020).

The crossing of the Dopper rams with the Precoce ewes contributes to the meat productivity increase of the resulting offspring. The live weight of crossbred lambs at birth exceeded 0.72 kg more than that of purebred peers. At the age of 4 months, it grew to 4.92 kg, and at the age of 7 months, the difference is 8.8 kg (Gavojdian *et al*., 2015).

In lambs of the Tatar meat-wool breed, the carcass weight for 5 months was 14.48 kg, internal fat - 0.50 kg, slaughter yield - 42.9%. The largest increase in carcass weight occurred over a period of up to 7 months with an increase in carcass weight by 48.20%, internal fat by 20.0% and slaughter productivity by 5.3% (Mokhnachova, 2021).

Among the fat-tailed sheep of the meat-sand-fat direction, the Yedilbay sheep can compete with the sheep of the English breed type in terms of precocity and meat productivity (Isaeva and Korotkevich, 2022).

Recently, scientists and industry specialists have bred Ordabasy sheep breed of meat-and-fat productivity, which is characterized by high live weight and precocity (Azhimetov *et al*., 2020).

The production of mutton using of the new Ordabasy sheep has become a more effective measure in the production of "dairy" mutton compared to other breeds. This indicates the effectiveness of breeding this unique breed to enhance the production of high-quality mutton. Delicatessen lamb is more competitive in the domestic and foreign markets (Ombayev *et al*., 2014).

In recent years, there has been a wide spread of Ordabasy sheep in the south-western zone. To maintain and increase productivity, it is necessary to improve and create new genotypes of the breed, which is a very relevant direction in coarse-wooled sheep breeding. In the last decade, in developed sheep-breeding countries, in particular, in the countries of the European Union and the Russian Federation, programs for the development of meat sheep breeding and lamb production have been developed and implemented, the share of which in the total cost of all products reaches 90% (Azhimetov *et al*., 2020).

One of the important breeding characteristics of sheep of fat-tailed breeds is the size of the fat tail. In fat-tailed sheep, the selection by the size of the fat tail is carried out visually when weaning at the age of 4-5 months and 1.5 years, where the evaluation of the size of the fat tail is carried out according to the following gradations: large, medium and small (Abdoli *et al*., 2023). The disadvantage of this method is that they do not always give an objective assessment due to the lack of metric criteria in the instructions that determine the true size of the fat tail and does not fully meet the requirements of modern breeding of fat-tailed coarse-wooled sheep breeds. Therefore, in order to solve the most important problem of increasing the efficiency of breeding fat-tailed sheep on the basis of improving economically useful features, it is necessary to develop new methods for selecting fat-tailed sheep according to the parameters of the fat tail, determining the true sizes of the fat tail and excluding subjective errors that occur when measuring the size of the fat tail.

The highly productive new Ordabasy breed, specialized in the production of lamb and mutton with year-round pasture maintenance, is in great demand by agricultural producers in all areas of animal husbandry in Kazakhstan (Pozharskiy *et al*., 2020).

MATERIALS AND METHODS

Ordabasy sheep

The experimental part of the scientific and experimental work was carried out in the "Ortay" Peasant Farm of the Ordabasy district of Turkestan region.

The selection of animals were done according to the size of fat tail: I type are ♀ small x ♂ large; II type are ♀ small x ♂ medium; III type and ♀ small x ♂ small.

Inclusion criteria were: Minimum age of 2.5 years for ewes and 3.5 years for rams, a live weight of at least 60 kg, minimum wither height of 85 cm, minimum chest depth of 35 cm, minimum chest width of 20 cm, minimum body length of 90 cm, minimum chest girth of 105 cm, minimum loin girth of 9 cm. Animals not adhering to these criteria were excluded. Additionally, signs and symptoms of illness. Artificial insemination of the breeding stock was carried out according to instructions for artificial insemination of sheep (Gibbons *et al*., 2019). Bonitization of fat-tailed sheep was carried out according to principles of bonitization of fat-tailed sheep, which is described elsewhere for another breed of cattle (Zhumanov *et al*., 2022). The growth and development of animals were studied according to the generally accepted methodology, which was adopted by a recent work in 2021 (Kharina *et al*., 2021). The determination of sheep productivity was carried out according to the methodology for assessing the meat productivity of sheep (Geß *et al*., 2020; Iskakov *et al*., 2017).

The main digital research materials were processed by the method of variation statistics. Statistical analysis of quantitative data was performed with SPSS v22.0 (IBM, NY, USA) using the independent student's t test. A P-value <0.05 was considered the threshold of significance.

RESULTS AND DISCUSSION

Inheritance of the fat tail size in the offspring with different options of fat tail size

Inheritance of the parameter of fat tail size in the offspring obtained from a heterogeneous and homogeneous selection of rams and ewes by the fat tail size was studied. With different options of the selection of parental pairs by the fat tail size among the offspring, there is a significant fluctuation in the size of the studied trait (Table I).

From the data in Table I it can be seen that in all selection options, offspring with small, medium and large sizes of fat tail were obtained. In the selection of animals (♂ small fat tail x ♀ large fat tail), the proportion of ewe hoggs and ram hoggs with a desirable small fat tail amounted to 27.6-29.2%, respectively, and lambs with a medium fat tail size of 24.4-20.1%, and with a large size of 48.0 and 50.7%, respectively. In the second selection option (♂ small fat tail x ♀ medium fat tail), lambs were obtained with a small fat tail by sex, respectively, 43.4-41.8%, with a medium size of 42.8 and 43.8%, with a large size of 13.8 and 14.4%. But in the third variant of selection (♂ small fat tail x ♀ small fat tail), these indicators amounted to 48.4 and 49.2%, respectively, by sex and the size of the fat tail, with a small size; 43.8 and 45.1% with a medium and 7.8 and 5.7% with a large. With a homogeneous selection option, the number of lambs with a small fat tail, respectively, by sex exceeds the lambs with a large fat tail by 40.6 and 43.5%.

Taking into account the above data, we studied the dynamics of the live weight of lambs obtained from various options for selecting meat-and-fat breeds of sheep according to the size of the fat tail. The obtained scientific data are shown in Table II.

Analysis of the data in Table II shows that in all selection options, the average live weight of lambs at birth was from 4.56 to 5.14 for ram hogs, from 4.41 to 4.87 kg for ewe hoggs. In terms of live weight at birth, there is no significant difference between the selection options and between ram hoggs and ewe hoggs. The highest rates of absolute growth of ram hoggs and ewe hoggs of all selection options are observed in the period from birth to 30 days of age (from 13.98 to 14.14 kg for ram hogs, from 13.62 to 13.76 kg for ewe hoggs). Then there is a decline in these indicators. as in other animals.

Evaluation of lambs obtained from different types of selections of parental pairs according to the criteria of fat tail size. live weight and exterior indicators

In order to verify the effectiveness of the proposed selection of the Ordabasy sheep breed by the fat tail size, production experiments were carried out, as well as to accept the criterion of the fat tail in the future as the main breeding trait for meat-and-fat sheep breeding.

Table I. Inheritance of the fat tail size of the Ordabasy breed in the offspring with different options of the selection of animals by the fat tail size.

Options for selecting animals according to the fat tail size		Sex of lambs	Number of lambs	Fat tail size of the lambs					
				Large		Medium		Small	
				n	%	n	%	n	%
♂ Small fat tail	x ♀ Large fat tail	♀	127	61	48.0±0.26	31	24.4±0.08	35	27.6±0.20
		♂	144	73	50.7±0.29	29	20.1±0.13	42	29.2±0.23
	x ♀ Medium fat tail	♀	138	19	13.8±0.16	59	42.8±0.16	60	43.4±0.26
		♂	146	21	14.4±0.16	64	43.8±0.23	61	41.8±0.27
	x ♀ Small fat tail	♀	128	10	7.8±0.07	56	43.8±0.24	62	48.4±0.26
		♂	122	7	5.7±0.08	55	45.1±0.24	60	49.2±0.25
Total			805	191	23.7±0.38	294	36.5±0.65	320	39.8±0.68

Table II. Dynamics of live weight of lambs obtained from different selection options in kilograms.

Indicators	Sex of lambs	Options of selection: ♂ Small fat tail × ♀ Large fat tail	♂ Small fat tail × ♀ Medium fat tail	♂ Small fat tail × ♀ Small fat tail
At birth	♂	5.14±0.27	4.87±0.28	4.56±0.38
	♀	4.87±0.28	4.62±0.29	4.41±0.18
30 days age	♂	19.28±0.26	18.87±0.27	18.54±0.17
	♀	18.63±0.27	18.24±0.18	18.12±0.17
60 days age	♂	30.54±0.14	30.11±0.35	29.54±0.13
	♀	28.74±0.29	28.46±0.14	28.17±0.13
90 days age	♂	39.66±0.18	39.28±0.37	28.92±0.14
	♀	38.06±0.31	37.83±0.12	37.37±0.12
120 days age	♂	44.98±0.23	44.50±0.28	43.87±0.11
	♀	42.40±0.29	42.17±0.11	41.89±0.11
Absolute growth (g)				
From birth to 30 days age	♂	14.14±0.18	14.00±0.56	13.98±0.20
	♀	13.76±0.57	13.62±0.21	13.71±0.20
30-60 days age	♂	11.26±0.36	11.24±0.06	11.00±0.23
	♀	10.11±0.39	10.22±0.25	10.05±0.23
60-90 days age	♂	9.12±0.13	9.17±0.05	9.38±0.26
	♀	9.32±0.26	9.37±0.26	9.20±0.25
90-120 days age	♂	5.12±0.27	5.22±0.07	4.95±0.36
	♀	4.34±0.30	4.34±0.30	4.52±0.38
Average daily gain (g)				
From birth to 30 days age	♂	471±0.17	467±0.87	466±0.34
	♀	459±0.88	454±0.35	457±0.33
30-60 days age	♂	375±0.21	374±0.99	367±0.58
	♀	337±0.83	341±0.61	335±0.59
60-90 days age	♂	304±0.13	306±1.10	313±0.75
	♀	311±0.64	312±0.21	307±0.83
90-120 days age	♂	171±0.26	174±1.54	165±0.29
	♀	145±0.64	145±0.64	151±0.29

In this regard, by analyzing the obtained indicators of rams and ewes by the size of the fat tail, the optimal parameters of the fat tail size are established, according to which it is possible to predict the maximum effect of selection in reducing fat tail fat and increasing the meat on a live sheep, at the same time, assuming the possibility of a high effect of the intended selection during the assortment of animals with a fat tail size of "small x large", "small x medium" and "small x small".

For the experiment, 3 groups of ewes at the age of 1.5 years were formed in the amount of 775 animals.

Ewes of the first group had a fat tail size over 4600 cm^3 (260 sheep), the second group from 3600 to 4600 cm^3 (278 sheep) and the ewes of the third group below 3600 cm^3 (237 sheep).

The rams used in the experiment had a small fat tail below 4600 cm^3. In the experiment, a homogeneous and heterogeneous selection of rams and ewes according to the fat tail size was used.

The frequency of occurrence of lambs of different categories according to the fat tail size in populations

Fertility of animals from a biological point of view is a very complex trait. The study of this trait is necessary to replenish the reserves of livestock of farm animals. At the same time, the main indicator in assessing the fertility of animals is the yield of lambs per 100 ewes.

In total, 805 lambs were obtained from a heterogeneous and homogeneous selection of parental pairs according to the fat tail size, and the yield of lambs per 100 ewes averaged 103.9% (Table III).

Table III. Fertility of ewes with different selection options for the fat tail size in percentages.

Fat tail size of: Rams	Ewes	No. of ewes	Offspring obtained: n	%	Sex of lambs: Ewe hoggs n	%	Ram hoggs n	%
Small	Large	260	271	104.2	132	48.7±4.7	139	51.3±5.1
	Medium	278	284	102.2	135	47.5±4.5	149	52.5±4.6
	Small	237	250	105.5	114	45.6±6.5	136	54.4±6.8
Herd average		775	805	103.9	381	47.3±3.9	424	52.7±3.8

With a heterogeneous selection of parental pairs "small x large" and "small x medium", the accounted indicator was 104.2% and 102.2%, respectively. And with a homogeneous selection of "small x small", this indicator turned out to be slightly higher and amounted to 105.5%. Of the total number of individuals, the proportion of ewe hoggs was 381 (47.3%) and ram hoggs - 424 (52.7%). However, there are slight differences in the yield of lambs per 100 ewes, depending on the size of the fat tail of ewes.

In all lambs obtained from different types of selection of parent pairs according to the criteria of fat tail, using the developed method, the size of the fat tail of each lamb was additionally determined.

Table IV shows the frequency of occurrence of lambs with different fat tail sizes, obtained from the selection of rams and ewes according to the fat tail size.

The variability of the fat tail size in the studied groups of lambs is significant. At the same time, in the group of

Table IV. The occurrence frequency of lambs with different fat tail sizes in rebounds.

The fat tail size of lambs. cm³	Number of lambs	Selection options											
		Small × Large				Small × Medium				Small × Small			
		Ewe hoggs		Ram hoggs		Ewe hoggs		Ram hoggs		Ewe hoggs		Ram hoggs	
		n	%	n	%	n	%	n	%	n	%	n	%
448.69	36	2	5.6	-	-	4	11.1	-	-	30	83.3	-	-
523.33	81	14	17.3	-	-	18	22.2	6	7.5	23	28.4	20	24.6
605.82	101	16	17.3	2	1.4	19	14.1	23	15.4	17	14.9	24	17.8
696.56	126	18	13.7	18	12.9	21	15.6	26	17.5	17	14.9	26	19.1
795.92	184	21	15.9	25	18.0	19	14.1	39	26.2	22	19.3	58	42.6
904.32	117	22	16.7	31	22.3	22	16.3	30	20.1	5	4.4	7	5.1
1022.13	90	23	17.4	26	18.7	19	14.0	21	14.1	-	-	1	0.7
1149.76	53	16	12.1	20	14.4	13	9.6	4	2.7	-	-	-	-
1287.60	17	-	-	17	12.3	-	-	-	-	-	-	-	-
Total	805	132	16.4	139	17.3	135	16.8	149	18.5	114	14.2	136	16.9

lambs obtained from the selection of "small x large", there are different fluctuations in the size of the fat tail, and depending on their sex, it ranges from 523.33 cm³ to 1149.76 cm³ and from 696.56 cm3 to 1287.60 cm³.

In the group of individuals obtained from the selection of "small x medium", the size of lambs of different sexes was studied, respectively, from 448.69 cm³ to 1149.76 cm³ and from 523.33 cm3 to 1149.76 cm³.

In lambs obtained from a homogenous selection of parental pairs according to the size of the fat tail, a decrease in the size of the fat tail is observed. So, in ewe hogs, this indicator ranged from 448.69 cm³ to 904.32 cm³.

The variability of the fat tail size in ram hoggs is spasmodic.

With different options for the selection of parental pairs according to the size of the fat tail among the offspring, there is a significant fluctuation in the value of the studied trait (Table V).

Table V. Inheritance of the fat tail size in the offspring of rams and ewes in the accepted selections in percentages.

The fat tail size of the parents		Lambs counted	Distribution of offspring according to the size of the fat tail		
Father	Mother		Over 1100 cm³	From 800cm³ to 1100 cm³	Below 800 cm³
Small	Large	271	19.6±5.4	37.6±4.8	42.8±5.9
	Medium	284	6.0±8.4	32.4±5.6	61.6±5.2
	Small	250	-	5.2±7.8	94.8±2.5
Average		805	8.7±6.8	25.7±2.7	65.6±1.3

An analysis of the materials presented in Table V shows that in the selections of parental pairs "small x large" and "small x medium", offspring with a value of more than 1100 cm³ ranged from 6.0% to 19.6%. The selection of parental pairs according to the size "small x large" made it possible to obtain "medium" (from 800 cm³ to 1100 cm³) individuals (37.6%) in terms of fat tail size and significantly differs from other options for selecting animals ($P < 0.05$). The highest yield of lambs (94.8%) with a fat tail size below 800 cm³ is observed with a homogeneous selection of parents with the same fat tail size and the result obtained is very highly reliable ($P< 0.001$). When selecting animals with a "small x medium" fat tail size, the proportion of lambs with a value from 800 cm³ to 1100 cm³ and below 800 cm3 increases in the offspring and, respectively, amounted to 32.4% and 61.6%.

Table VI. The occurrence frequency of animals of different fat tail sizes in the populations of the Ordabasy sheep breeds.

Classes of animals by fat tail size, cm³	Animal occurrence frequency				Total number of animals	
	Rams		Ewes			
	n	%	n	%	n	%
3052 – 3515	-	-	147	19.0	147	18.1
3516 – 3979	1	2.9	108	13.9	109	13.5
3980 – 4443	3	8.6	147	19.0	150	18.5
4444 – 4907	7	20.0	209	27.0	216	26.7
4908 – 5371	8	22.8	93	12.0	101	12.5
5372 – 5835	7	20.0	71	9.1	78	9.6
5836 – 6299	6	17.1	-	-	6	0.7
6300 – 6763	3	8.6	-	-	3	0.4
Herd average	35	100	775	100	810	100

Table VI shows the frequency of occurrence of animals according to the size of the fat tail.

As can be seen from the data in Table VI, the compiled variation series clearly reflects the high variability of the fat tail size in the studied groups of rams and ewes. In rams, the fat tail size ranges from 4186.67 cm^3 to 6577.29 cm^3. Among rams, rams with fat tail size from 4500 to 6300 cm3 had the highest frequency of occurrence and amounted to 17.1% and 22.8%, respectively. The lowest frequencies are observed in rams with tails up to 4500 cm^3 and above 6300 cm^3 (8.6%).

Table VII. Parameters of the fat tail size of the Ordabasy sheep.

Fat tail size	Fat tail size (cm^3)			
	n	Rams	n	Ewes
Large	11	over 5600	373	over 4600
Medium	19	from 4600 to 5600	255	from 3600 to 4600
Small	5	below 4600	147	below 3600

In ewes, the fat tail size is in the range of 3052.0 cm3 to 5835.0 cm^3. The highest frequencies of occurrence in ewes with a fat tail size of 4444.0 to 4907.0 cm^3 were within 21.2% and 28.5%. The lowest frequencies are observed in ewes with a fat tail size of up to 5372.0 cm^3 and above 5835.0 cm^3 (6.8%).

In general, in the populations of the Ordabasy sheep breed, the occurrence frequency of rams with different fat tail sizes ranged from 2.9% to 22.8%.

This received data indicates that selection for this trait was not carried out intensively enough. Therefore, further progress in improving the meat productivity of fat-tailed sheep of the Ordabasy breed can come at the expense of individual selection according to their fat tail size.

Knowing the actual parameters of the fat tail with different sizes in all the studied animals. established the true size of the fat tail (Table VII).

At the same time, rams with a large fat tail had a fat tail size of more than 5600 cm^3, with a medium size from 4600 cm^3 to 5600 cm^3 and with a small size - below 4600 cm^3.

The size of the fat tail in ewes was subdivided in a similar way: the largest one was over 4600 cm^3, medium - from 3600 cm^3 to 4600 cm^3 and small - below 3600 cm^3.

Based on this we determined the reliability of the difference between the visual and metric method of selecting fat-tailed sheep by the size of the fat tail (Table VIII).

The data in Table VIII shows that there is almost a complete mismatch between the two compared methods. Thus, for example, in visual assessment, the number of animals with a large fat tail size was 42.2%, with an average size of 51.4%, and with a small fat tail, 6.3%.

Table VIII. Results of assessing the difference between different methods according to the Student's criterion for the Ordabasy breed.

Fat tail size	Assessment methods		Differences		Significance of difference	
	Visual	Metric	n	%	t_d	P
Large	42.2±1.7	33.5±1.6	70	26.9	3.8	P<0.001
Medium	51.4±1.8	44.0±1.7	60	23.1	4.9	P<0.001
Small	6.3±0.8	22.5±1.5	130	50.0	48.3	P<0.001

With the metric method, the number of animals with a large and medium fat tail compared to the visual assessment is significantly less and amounted to 343.5% and 44.0%, respectively. On the contrary, the number of animals with a small tail fat increased significantly, and amounted to 22.5% or more per 130 animals.

Data on the presence of a relationship between live weight, exterior assessment and the fat tail size of lambs are shown in Table IX. Analysis of the data in Table IX shows the diversity of the relationship between the size of the fat tail of lambs with exterior indicators and live weight.

Table IX. Relationship of the fat tail size of lambs with their live weight and body conformation.

Live weight and body measurements of lambs	$r \pm m_r$	Reliability
Live weight	+0.862±0.049	P<0.001
Height at the withers	+0.874±0.047	P<0.001
Chest width	+0.511±0.084	P<0.001
Chest depth	+0.885±0.045	P<0.001
Oblique length of the body	-0.722±0.094	P<0.001
Chest girth	+0.823±0.041	P<0.001
Metacarpus girth	+0.951±0.030	P<0.001

At the same time, a high positive correlation was established between the fat tail and live weight, as well as body measurements of lambs. The fat tail value of lambs positively correlates with their live weight (0.862±0.049), height at the withers (0.874±0.047), chest width (0.511±0.084), chest depth (0.885±0.045), chest girth (0.823±0.041), metacarpus girth (0.951±0.030), and the oblique length of the body had a negative relationship (0.722±0.094).

Table X. Results of the control slaughter of ram hoggs at the age of 4 and 16 months in kilograms.

Slaughter indicators	Fat tail size at the age of 4 months			Fat tail size at the age of 16 months		
	Large (n=3)	Medium (n=3)	Small (n=3)	Large (n=3)	Medium (n=3)	Small (n=3)
Pre-slaughter weight (kg)	41.80±0.15	41.43±0.28	41.18±0.25	98.33±0.65	93.20±0.22	88.63±0.36
Carcass weight (kg)	21.98±0.27	21.24±0.14	20.26±0.26	48.36±0.33	46.88±0.28	46.11±0.62
Carcass yield (%)	52.6	51.3	49.2	49.2	50.3	52.0
Incl. the fat tail weight (kg)	3.03±0.13	2.34±0.20	2.12±0.18	5.76±0.47	4.50±0.45	3.72±0.40
Fat tail yield (%)	7.25	5.65	5.15	5.86	4.83	4.20
Internal fat weight (kg)	0.51±0.06	0.41±0.05	0.38±0.08	0.65±0.08	0.72±0.06	0.91±0.06
Internal fat yield (%)	1.22	0.99	0.92	0.66	0.77	1.03
Slaughter weight (kg)	22.51±0.29	21.87±0.21	21.57±0.39	50.79±0.64	47.42±0.47	46.58±0.88
Slaughter yield (%)	53.9	52.8	52.4	51.65	50.88	52.56
Meat (kg)	15.02±0.13	14.99±0.28	14.64±0.31	36.14±0.56	36.47±0.84	36.99±0.53
Bones (kg)	3.93±0.25	3.93±0.08	3.50±0.20	6.46±0.40	5.91±0.36	5.40±0.35
Meatiness ratio	3.82±0.24	3.81±0.18	4.18±0.16	5.59±0.32	6.17±0.50	6.85±0.51

Thus, the calculation of correlation coefficients shows that such factors as live weight and body size are of decisive importance for the formation of fat tail fat in lambs.

Moreover, the increase in the live weight of lambs and its size provides a positive correlation between the fat tail size decreases and vice versa, the shorter, the more their size increases. This phenomenon is especially well manifested in lambs, starting from 4 months of age.

Meat indicators of the Ordabasy sheep with different fat tail sizes

One of the main indicators indicating the breed characteristics of fat-tailed sheep meat-and-fat productivity is the degree of their meatiness.

To determine the meat value of the Ordabasy sheep, taking into account their fat tail size, a control slaughter of rams at the age of 4 and 16 months was carried out (Table X).

The results of the control slaughter of ram hoggs at the age of 4 months showed that ram hoggs with a large fat tail exceeded the slaughter rates of their peers at the age of 4 months with a medium and a small fat tail. In ram hoggs with a large fat tail, the slaughter yield was 52.6%, and for rams with a medium fat tail, the slaughter yield was 51.3%, and with a small one - 49.2%.

The slaughter weight ranges from 21.57 to 22.51 kg, depending on the size of the fat tail of the ram hoggs, and the meat yield from 15.02 kg to 14.64.

With an increase in the meat part of the carcass, the bone mass accordingly increases to 4.18 kg. The coefficient of meatiness at 4 months of age with a fat tail of a large size was 3.82, medium - 3.81 and small - 4.18.

The results of the control slaughter of rams at the age of 16 months are shown in Table X.

The data in Table X show that in animals with a small fat tail, with an average live weight of 88.63 kg, the carcass yield is 52.56% including carcass weight 46.11 kg and fat tail weight 3.72 kg. In the process of deboning the carcass, it was found that the yield of meat corresponds to 36.99 kg, the yield of bones is 5.40 kg. The meat factor is 6.85 kg. In ram hoggs with a large and with a medium fat tail, the carcass yield is 50.88-51.56%, meat yield in the carcass, respectively, 36.14 to 36.47 kg. The yield of the bone was 5.91–6.46 kg, respectively, the meat ratio was 5.59–6.17 kg.

DISCUSSION

In the selection of animals (♂ small fat tail x ♀ large fat tail), the number of lambs with a large fat tail exceeded the lambs with a small size, respectively, by sex by 20.4 and 21.5%. The live weight of farm animals is the most important economic and biological indicator, closely related to their productivity and characterizes, first of all, the growth and development of the organism. The change in live weight over a certain period of time evaluates the rate of growth and development, which in turn are the most important economic features.

At the age of 30 days, a high live weight was noted in the ram hoggs of the first selection option and it amounted to 19.28 kg in ram hoggs, 18.63 kg for the ewe hoggs of the same selection option. Here, too, there is no significant difference between the selection options and the sex of the lambs. The same trend in absolute and average daily growth is observed in all selection options and ages of growth and development of lambs. Analyzing the data obtained on the dynamics of the live weight of lambs of all selection options, we can say that the growth of lambs in all periods of development occurred evenly.

It should be noted that in the first selection options in all periods there is a large live weight of lambs, which can be explained by the influence of a large fat tail on the live weight. The result of the linear growth of animals shows that the variability of this trait is of the same nature as the live weight. Sheep born from a homogeneous “small fat tail x small fat tail” selection have the lowest measurements of body articles in height at the withers by 0.6-0.9 cm; rump bone height - 0.7-1.0 cm; oblique length of the body - 0.1-0.6 cm; chest girth - 0.4-0.6 cm; chest depth - 0.3-0.6 cm and hips width - 0.4-0.6 cm compared with the data of analogues from two other selections. And this lag continues, albeit slightly, until the age of 4 months.

An analysis of the calculated body indices of the lambs of the meat-and-fat direction of productivity in the context of various selection options showed that somewhat high indexes of long-leggedness are observed in lambs obtained from a homogeneous “small fat tail x small fat tail” selection at birth by 1 and 4 months of age, these data are comparable or slightly inferior. Similar phenomena are observed for other indices by selection options (Deribe *et al*., 2021; Djaout *et al*., 2022; Haslin *et al*., 2022; Khan *et al*., 2023).

In terms of the birth of lambs with different tail sizes, the reliability of the results of the preliminary assessment of lambs by the size of the fat tail obtained from different types of selection is confirmed by the correlation coefficient for this trait between parents and offspring. At the same time, between the selection of parental pairs by the size of the fat tail and the offspring fat tail size, a high dependence and positive correlation was observed - $r = 0.496 \pm 0.059$ with a reliability of $P < 0.001$. An additional confirmation of the above is the share of the influence of the fat tail size of the parents on their offspring, the results of the variance analysis. It was established that the influence of parental categories on the size of the fat tail on the offspring is significant and the share of their influence is $\eta x2= 0.249 \pm 0.007$ with a reliability of $F = 35.6$ ($P<0.001$). In general, the influence of the factor taken into account can be at least 23.8% and not more than 26.0% of the total influence of the total sum of factors. The inheritance of the fat tail size in the offspring obtained from a heterogeneous and homogeneous selection of rams and ewes was studied.

According to our findings on the inheritance pattern of tail size in accepted selections, we made the following statements:

Selection and assortment of fat-tailed sheep according to the size of the fat tail allows to pre-determine the most promising individuals and widely use them in breeding, opens up the possibility of a more targeted selection of pairs to obtain offspring with the desired size of the fat tail. In pedigree sheep breeding of the meat-and-fat direction of productivity, it is necessary to include the size of the fat-tailed sheep in the number of breeding traits, as an obligatory element in the selection and assortment of fat-tailed sheep.

Studies have been carried out to determine the true size of fat tail in the Ordabasy sheep breeds (Azhimetov *et al*., 2020; Ombayev *et al*., 2014). First, the desired proportions of the parameters of the fat tail were determined based on measuring the length of the fat tail from the last sacral vertebra to the tip of the caudal vertebra and the width of the rear part of the tail, using the suggested formula by Fischer and Inke for ellipsoid figures:

$$V = \frac{\pi}{48}(\text{length} + \text{width of fat tail})^3$$

Then the fat tail size of all selected rams and ewes was calculated in the amount of 35 and 207 animals, respectively. Based on the data obtained, we make classes of animals according to the size of the fat tail, in this case, cubic centimeters (cm^3) are taken as a measure of volume.

According to Table VII, the recommended limits of fat tail size are a new breeding parameter, and their use in breeding fat-tailed sheep of the Ordabasy breed increases the efficiency of breeding by the size of the fat tail. Reliability is truly reflective general parameters of the selected indicator. A significant difference between the two compared indicators accurately characterizes the difference between the selected methods. Therefore, the calculation of the reliability of the difference between the results obtained is of great importance for research work.

As for the results listed in Table VIII, in general, the complete discrepancy between the results of visual assessment indicates the need to move from the primitive method of selecting animals according to the size of the fat tail to the objective one. Therefore, using the developed method for estimating the fat tail size in meat-and-fat sheep, it is possible to reliably predetermine the selection results. One of the main indicators of fat-tailed sheep of the meat-and-fat direction of productivity is the live weight and physique, which are indicated by their qualitative transformation in the process of individual development. However, some selection and genetic aspects of breeding improvement of animals have not been previously studied and the selection criteria have not been sufficiently developed in relation to fat-tailed sheep breeding. In particular, the degree of divergence of the live weight of genotypes depending on their fat tail size. There is only information about the difference in body weight between females and males. Therefore, along with traditional methods, the development of indirect selection criteria is of particular relevance, with the help of which it is possible to obtain not only complete information about the genetic characteristics and potential of animals, but also allowing them to be used as tests for an early predictive assessment of meat productivity. Additionally, main value of the correlation analysis of research work is that it allows finding out the relationship between indicators, characterizing animals according to various economically useful traits.

Lastly, it should be noted that the meat indicators of the Ordabasy sheep breed depends very much on the size of their tail. In addition, animals with large tail sizes are characterized by the highest tail fat weight and internal fat, as well as a low meat ratio.

Limitations

While we tried to optimize our methodology with regards to the subject matter, the present study is limited in many regards, with the most important factors being the sample size, failure to follow-up the offspring for a longer period of time or even performing a second-generation breeding to confirm the findings in a transgenerational manner. Accordingly, further studies are warranted to attest to the veracity of our findings.

CONCLUSION

The use of stud rams with a small fat tail size in breeding can increase the number of animals with the same desired fat tail size. This selection trait, like the size of the fat tail, is fairly well transmitted to offspring. The results of the selection of animals according to the fat tail size indicate the feasibility of using it as one of the breeding methods for the Ordabasy sheep breed which makes it possible to obtain the desired types of genotypes for further improving the quality of their meat products. Ordabasy sheep have a high ability to accumulate fat and can be classified as a meat-and-fat type. Lambs with a small fat tail have very high meat ratios, they are characterized by the smallest weight of tail fat and the largest weight of internal fat. Therefore, these animals can accumulate visceral fat, and such genotypes can be classified as meat types. Sheep with an average fat tail have the ability to produce fat in the inner part of the body. They are characterized by an average meat ratio and can be classified as meat-and-fat types of sheep.

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IRB approval

Institutional Supervisory Board No. 17 dated November 24, 2019 of Shymkent University approved the research work.

Statement of conflict of interest

The authors have declared no conflict of interest.

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