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Characteristics of lambs and milk productivity of Tsigay breed ewes and F1 and F2 crosses with Assaf dairy sheep

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Abstract

This article presents data on the growth and development of lambs from birth until weaning, from their mothers of the Tsigay breed, as well as crossbreeds F_1 ♀Tsigay X ♂Assaf, F_2 ♀ Tsigay 25% X ♂Assaf 75%, and F_3 ♀Tsigay 12.5% X ♂Assaf 87.5%. The measurements of udder size, udder volume, milk productivity for twenty days after lambing, fostering and milking periods, and overall lactation were recorded. Additionally, the average daily milk yield, milk composition, fat, and protein content in the milk were analyzed. The average weaning weight of F_3 lambs from their mothers was 32.81±0.99 kg, F_2 was 29.40±1.78 kg, which is 3.41 kg lower, and F_1 was 28.56±1.11 kg, significantly lower ($P \leq 0.01$) by 4.25 kg. In the first 20 days after lambing, the milk productivity of F_2 ewes was 64.09±7.85 kg, higher compared to F_1 ewes by 15.41 kg and by 27.87 kg ($P \leq 0.01$) compared to purebred Tsigay ewes. The largest udder volume was found in F_2 ewes, measuring 2275.20±257.90 cm^3, which is 785 cm^3 less than in F_1 ewes and 943 cm^3 less than in purebred Tsigay ewes. The difference between the two groups is statistically significant ($P \leq 0.05$). Over 208 days of lactation, crossbred F_2 ewes produced 268.38±33.67 kg of milk, which is 62 kg more than F_1 ewes, who produced 206.00±26.86 kg in 207 days, and 126 kg more than purebred Ţigay ewes, who produced 141.72±13.83 kg in 198 days. The difference is statistically significant ($P \leq 0.01$). Regarding the chemical composition, there were slight differences between purebred Tsigay ewes and F_1 ♀Tsigay X ♂Assaf crossbreeds, while the fat and protein percentages were the same (9.03 and 8.91, respectively). In F_2 ♀ Tsigaiy25% X ♂Assaf 75%, fat, protein, and fat +protein content was higher.

Keywords: Ewe; Lamb; Milk; Fat; Protein; Lactation

Introduction

Sheep are animals with versatile productivity and can compete with any other livestock species when it comes to producing meat, wool, milk, lamb skins for making hats and collars, and sheepskins for fur products.

However, in recent times, due to low prices for wool, sheepskins, and even Karakul pelts, the sheep industry has become unprofitable in many farms. One of the contributing factors is the lack of adequate government support and poorly established market conditions. Consequently, there has been a decline in sheep popu-

lations, necessitating the need to increase the milk productivity of sheep, which is in high demand.

Sheep milk is a highly nutritious food product with significant demand in both domestic and international markets, especially in the restaurant and tourism industries, sanatoriums, and other places of mass recreation. In the transitional period of market relations, improving sheep farming efficiency, alongside meat and wool productivity, is largely dependent on the level of milk production in ewes, as well as the technology of milking and milk processing. Utilizing sheep's milk for food production not only supplements the food market resources but also enhances the industry's competitiveness [Toshchv and Tsaregorodtseva, 1997].

Currently, in sheep breeding in many countries, breeding is focused on increasing sheep milk productivity through the use of various specialized breeds. These breeds are utilized both for producing and exploiting user animals (hybrids) and for creating new types and specialized lines.

When working with imported breeds, it is essential to consider the influence of the environment on their adaptation and the maintenance of milk productivity parameters [Macciotta et al., 1999].

In Moldova, to increase the milk productivity of local sheep, the first batch of Assaf sheep breed was imported from Veliko Tarnovo (Bulgaria) in 2014, and later from Spain in four other farms.

Assaf sheep are a result of crossing Avassi sheep with East Friesian sheep. In their native Israel, the Assaf breed is recognized as the best breed for both milk and meat, with high carcass yield and excellent taste. The breed is well adapted to semi-intensive and intensive farming systems, with a focus on meat and milk productivity.

Under Israeli conditions, where ewes typically have about three lambings every two years, their annual milk productivity reaches 450 liters. The average milk yield during intensive farming is 334 liters of milk over 220 days of lactation with 7.2% fat content and 5.5% protein. After its introduction in Spain, the breed quickly spread across Europe.

To make use of imported breeds, it is necessary to determine the impact of various factors, such as milk productivity in the first twenty days after lambing, during the fostering and milking periods, and overall lactation, as well as the average daily milk yield during these periods [Nevyana Stancheva et al., 2022].

The objective of this study was to investigate the growth and development of lambs from birth until weaning, from their mothers of the Tsigay breed, as well as crossbreeds F_1 ♀Tsigai X ♂Assaf and F_2 ♀Tsigai 25% X ♂Assaf 75%. The study involved measurements of udder size, udder volume, milk productivity for twenty days after lambing, fostering and milking periods, and overall lactation. Additionally, the average daily milk yield, milk composition, fat, and protein content in the milk were analyzed.

Materials and Methods

The material for the research consisted the ewes of the Tsigay breed, crossbreeds F_1 ♀Tsigay X ♂Assaf, and F_2 ♀Tsigay 25% X ♂Assaf 75%, as well as their offspring of the first, second, and third generations. The study has been carried out in the project: 20.80009.5107.20 "Management of the genetic potential and productions of breed animals reproduced and exploited in the pedoclimatic conditions of the Republic of Moldova".

Milk productivity was studied as follows: In the first 20 days after lambing - when the lambs reached 20 days of age, individual weighing was conducted, and the weight gain during this period was calculated and multiplied by a coefficient of 5.35 (milk consumption for 1 kg of weight gain).

From 20 days of age until weaning during the fostering and milking period - this was achieved by performing control milk yields according to the methods specified in the "Instructions for Evaluating Morphoproductive Qualities of Specialized Breeds, Populations, Types, and Synthetic Lines of Dairy Sheep in the Republic of Moldova" [Mashner et al., 2017].

During the control milk yields, milk samples were collected, and the chemical composition of the milk was analyzed using the Lactosan MCC device. Based on the milk quantity during lactation and the fat and protein content, the amount of milk fat and protein was calculated.

The development of the mammary gland in sheep of the mentioned genotypes was studied using the measurement method [Kirikova, 2006]:

• Udder length from the rear convexity of the udder to the front edge at the base (measured with a compass).

• Udder width above the teats' quarters (measured with a compass).

• Udder circumference at the base, along a horizontal line at the front edge of the udder base (measured with a tape measure).

• Udder depth, measured vertically from the abdominal wall to the teat base (measured with a tape measure).

• Udder volume, calculated by multiplying the udder area (calculated through the circumference measurement) by its depth expressed in cm^3.

• Teat length from their base to the tip (measured with a caliper).

• Teat thickness in the front third (measured with a caliper).

The statistical analysis of the experimental results to assess the significance of differences involved data grouping, calculation of the arithmetic mean (M), error (m), and significance criterion [Plokhinsky, 1978].

Results and Discussion

At the peasant farm "Borzin Georgiy Ivanovich," we examined the growth and development indicators of crossbred lambs F_1 ♀Tsigay X ♂Assaf, F_2 ♀Tsigay 25% X ♂Assaf 75%, and F_3 ♀ Tsigay 12.5% X ♂Assaf 87.5% from birth until weaning, as well as the udder measurements, milk productivity, and chemical composition of the milk of their mothers. The live weight of crossbred lambs at birth was 5.09±0.59 kg for F_2 and 4.32±0.37 kg for F_3, which was 0.98 kg and 0.21 kg higher, respectively, compared to F_1 crossbred lambs (Table 1).

The same trend in absolute weight gain was observed at the age of twenty days. The weight gain at 20 days for F_2 was 10.78±0.75 kg, and for F_3 it was 10.98±0.43 kg, while for F_1 crossbred lambs, it was 9.49±0.61 kg, which is respectively 1.29 kg and 1.49 kg higher compared to F_1 crossbred lambs. Based on the obtained weight gains from birth to 20 days of age, the milk productivity of the ewes was calculated using a coefficient of 5.35, representing the amount of milk consumed by a lamb to gain one kilogram of weight. The milk productivity of second-generation ewes,

Table 1. Lamb Growth and Development and Milk Productivity of Ewes in the First 20 Days after Lambing.

Indicators	Maternal foundation								
	Tsigay breed			F_1 ♀Tsigay X ♂Assaf			F_2 ♀Tsigay 25% X ♂Assaf 75%		
	Offspring								
	F_1 ♀Tsigay X ♂Assaf, n-7			F_2 ♀Tsigay 25% X ♂Assaf 75% , n-8			F_3 ♀Tsigay 12,5% X ♂Assaf 87,5%, n-9		
	M ± m	σ	Cv%	M ± m	σ	Cv%	M ± m	σ	Cv%
Birth weight, kg	4.11±0.50	1.23	29.88	5.09±0.59	1.55	30.44	4.32±0.37	1.05	24.29
Weight at 20 days, kg	9.49±0.61	1.48	15.64	10.78±0.75	1.97	18.31	10.98±0.43	1.21	11.01
Weight gain, kg	5.37±0.37	0.91	17.02	5.69±0.20	0.54	9.42	6.66±0.13	0.36	5.37
Milk yield, l	36.22±4.21**	8.43	23.27	48.68±7.54	15.09	30.99	64.09±7.85	15.71	24.50
Weaning weight, kg	28.56±1.11**	2.73	9.55	29.40±1.78	4.72	16.04	32.81±0.99	2.80	8.55

***P ≤ 0,01*

from which F_3 crossbred lambs were obtained, amounted to 64.09±7.85 kg of milk, which is higher compared to F_1 ewes by 15.41 kg and significantly higher by 27.87 kg ($P \leq 0.01$) compared to purebred Tsigay ewes. The live weight of F_3 lambs at weaning was 32.81±0.99 kg, which is 3.41 kg lower than F_2 lambs and 4.25 kg significantly lower than F_1 lambs ($P \leq 0.01$). These results indicate that F_2 and F_3 lambs achieved better growth and development due to the higher milk productivity of their mothers compared to F_1 lambs. The live weight of F_1 lambs is 13.0% less than F_3 and 2.9% less than F_2 lambs. In addition to milk productivity, the obtained results were influenced by the heterosis effect.

To study udder development in ewes, measurements were taken ten days after the first control milking, considering the length, width, depth, and circumference of the udder, as well as the length and perimeter of the teats [Kirikova, 2006].

Table 2 presents the measurements obtained from purebred Tsigay ewes and their crossbreds resulting from their mating with rams of the milk-producing Assaf breed.

The crossbred ewes F_2 ♀Tsigay 25% X ♂Assaf 75% showed higher udder measurements of length and width compared to F_1 ♀Tsigay X ♂Assaf by 33.3% and 21.8%, respectively, and compared to purebred Tsigay ewes by 37.5% and 26.4%, respectively. The depth and circumference of the udder in F_1 ♀Tsigay X ♂Assaf crossbred ewes were higher compared to Tsigay ewes by 5.7% and 21.3%, and compared to F_1 ♀Tsigay X ♂Assaf by 7.3% and 0.5%, respectively. The length and perimeter of the teats were significantly higher in purebred Tsigay ewes. Based on these measurements, we calculated the udder volume, which is directly proportional to the measured values used in its calculation. The highest udder volume was found in second-generation ewes and amounted to 2275.20±257.90 cm3, which is 785 cm^3 less compared to the first generation and 943 cm^3 less compared to purebred Tsigay ewes, with both differences being significant ($P \leq 0.05$).

Considering that the main goal of the conducted research is to study the crossbreeding methods of Tsigay sheep raised in the Republic for increasing their milk productivity, especially with rams of the Assaf dairy breed, the milk productivity of purebred Tsigay ewes used as the maternal basis for obtaining experimental animals, as well as the crossbred animals resulting from the crosses, was investigated.

During the research period, the main lactation stages of the sheep were studied: the first 20 days after lambing, the fostering, milking periods, and the overall lactation period, taking into account the duration of each period (Table 3).

During the fostering period, which lasted for an average of 108 to 117 days, the milk yield of second-generation crossbred ewes ♀Tsigay25% X ♂Assaf 75% was 210.04±30.72 kg, which was 52 kg higher compared to first-generation crossbreds ♀Tsigay X ♂Assaf, and 102 kg higher com-

Table 2. The values of udder measurements in the Tsigay breed and crossbred sheep.

Measurements	Tsigay	F_1 ♀Tsigay X ♂Assaf	F_2 ♀Tsigay 25% X ♂Assaf 75%
of Udder:			
length	6.40±0.57	6.60±0.67	8.80±0.55
width	10.60±0.45	11.00±0.61	13.40±0.57
depth	19.40±1.10	20.50±1.98	19.10±0.67
perimeter	33.80±1.85	41.00±2.85	40.80±1.08
volume	1332.00±186.47*	1460.00±145.55*	2275.20±257.90
of Teats:			
length	4.20±0.22	3.80±0.52	3.30±0.14
perimeter	7.10±0.62	6.60±0.74	5.30±0.45

**P ≤ 0,05*

Table 3. The milk productivity indicators.

Indicators	Tsigay	F_1 ♀Tsigay X ♂Assaf	F_2 ♀Tsigay 25% X ♂Assaf 75%
Udder volume	1332±186	1460±146	2275±258
Suckling period, days	108.2±6.6	117.8±2.38	116.6±7.29
Milk productivity in the first 20 days of lactation, kg	36.22±4.21**	48.69±7.54	64.09±7.85
Milk productivity during the suckling period, kg	108.24±10.89**	158.52±22.69	210.04±30.72
Milking period, days	90.0±0.00		
Milk productivity during the milking period, kg	33.48±3.17***	47.48±7.61	58.42±4.98
Lactation period, days	198.0±6.60	206.80±2.32	207.60±7.60
Milk productivity for lactation, kg	141.72±13.83**	206.00±26.86	268.38±33.67
Average daily yield, g	718.0±77.06**	995.0±137.49	1293.2±135.14

***P ≤ 0,01; ***P ≤ 0,001*

pared to purebred Tsigay ewes, with both differences being statistically significant (P ≤ 0.01).

Currently, the main profit for sheep breeders in peasant and farm households comes from lamb meat, adult mutton, and cheese produced from sheep's milk. Therefore, special attention is given to feeding sheep during the milking period. Over the 90-day milking period, the second-generation crossbred ewes produced 24.94 kg more milk compared to the control group of purebred Tsigay ewes and 10.94 kg more compared to purebred Tsigay ewes.

The overall milk productivity indicators for the entire lactation period are of particular interest. Over the 208-day lactation period, second-generation crossbred ewes produced 268.38±33.67 kg of milk, which is 62 kg more than the first-generation crossbred ewes, from which 206.00±26.86 kg of milk was obtained in 207 days, and 126 kg more than purebred Tsigay ewes, which produced 141.72±13.83 kg of milk in 198 days, with all differences being statistically significant (P ≤ 0.01). The average daily milk yield was also higher in the second-generation crossbred ewes by 298.2 g compared to first-generation crossbred ewes and by 528.2 g (P ≤ 0.01) compared to purebred Tsigay ewes.

During the control milking period, milk samples were collected for research on the chemical composition (Table 4).

The obtained results indicate that there are slight differences in the chemical composition between purebred Tsigay ewes and first-generation crossbred ♀ Tsigay X ♂Assaf. The percentages of fat and DDMR are identical at 9.03% and 8.91%, respectively.

For crossbred ewes F_2 ♀ Tsigay 25% X ♂Assaf 75%, the main indicators of the chemical composition are lower compared to both purebred Tsigay ewes and F_1 ♀ Tsigay X ♂Assaf. The fat content is significantly lower by 1.49% (P ≤ 0.001) compared to purebred Tsigai ewes, as for DDMR**,** lactose, salts, and protein, there is a slight negative difference of 0.09%, 0.10%, 0.02%, and 0.08%, respectively, compared to purebred Tsigay ewes.

Taking into account the milk productivity obtained for each group of ewes during the lactation period and the chemical composition of the milk, Table 5 presents the calculations for the fat and protein yield.

Overall, in the F_2 ♀ Tsigay 25% X ♂Assaf 75% crossbreeds, fat, protein, and fat+protein yield are higher. More fat to F_1 by 1.64 kg and to

Table 4. The chemical composition of milk, %.

Statistical Indicators	Fat	DDMR	Density,A^0	Lactose	Salts	Protein
Tsigay						
M±m	9.03±0.13***	8.91±0.20	28.47±0.39	4.06±0.10	0.66±0.01	4.26±0.03
δ	0.90	1.37	2.64	0.66	0.07	0.22
Cv, %	9.97	15.36	9.28	16.25	10.33	5.14
F_1 ♀ Tsigai X ♂Assaf						
M±m	9.03±0.15***	8.91±0.06	27.86±0.18	4.00±0.03	0.64±0.00	4.23±0.03
δ	1.03	0.42	1.20	0.18	0.03	0.19
Cv, %	11.42	4.69	4.30	4.54	4.52	4.58
F_2 ♀ Tsigai 25% X ♂Assaf 75%						
M±m	7.54±0.14	8.82±0.07	28.61±0.23	3.96±0.03	0.64±0.01	4.18±0.04
δ	0.91	0.50	1.56	0.22	0.04	0.24
Cv, %	12.11	5.66	5.44	5.66	5.64	5.69
+/- to Tsigai	- 1.49	- 0.09	+ 0.14	- 0.10	- 0.02	- 0.08

$***P \leq 0{,}001$

Table 5. The fat and protein yield.

Indicators	Tsigay	F_1 ♀ Tsigay X ♂Assaf	F_2 ♀ Tsigay 25% X ♂Assaf 75%
Milk productivity for lactation, kg	141.72±13.83	206.00±26.86	268.38±33.67
Average daily yield, g	718.0±77.06	995.0±137.49	1293.2±135.14
Fat content, %	9.03±0.13	9.03±0.15	7.54±0.14
Protein content, %	4.26±0.03	4.23±0.03	4.18±0.04
Fat yield, kg	12.80	18.60	20.24
Protein yield, kg	6.04	8.71	11.22
Fat + protein yield, kg	18.84	27.31	31.46
Fat and protein yield per 1 kg of milk, g	132.9	132.5	117.2

Tsigay sheep by 7.44 kg for protein, respectively 2.51 kg and 5.18 kg and fat + protein 4.15 kg and 12.62 kg. When recalculating the yield of fat and protein per 1 kg from Tsigay sheep and first generation crossbreeds, respectively, received 132.9 g and 132.5 g, which is 15.7 - 15.3 g higher in relation to the crossbreeds of the second generation as a result higher percentage of fat and protein in milk.

Conclusions

Milk productivity of Tsigay sheep and their crossbreeds with the Assaf breed for 204 days lactation at Tsigay sheep was 141.72±13.83 kg, F_1 Tsigay x Assaf 206±26.86 kg and F_2 F_2 ♀Tsigay 25% X ♂Assaf 75% 268.38±33.67. From the data presented, it can be concluded that crossing local breeds with specialized dairy breeds

allows increase milk production from 45 to 89%.

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