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Research Article

Least Squares, Simple Linear Regression, and Pearson Correlation Analysis between the Lactation Milk Yield of Norduz Ewes and Their Lambs' Live Weight

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Abstract: This study aimed to determine the lactation milk yield of Norduz ewes and to determine the effects of milk yield on their lambs' growth and development characteristics. Additionally, the correlations between the sheep's milk yield, lambs' live weight, and affecting factors were determined. The study was conducted at the Van University of Yüzüncü Yıl Agricultural Research Center. In the study, 61 Norduz ewes and 66 male and female lambs they bore were included. The sheep were milked at 30-day intervals until the 180th day. Similarly, the lambs were weighed at 30-day intervals from birth to 180th day. The means and standard errors of the milk yields were obtained on the 30, 60, 90, 120, 150th, and 180th days of milking. The live weight means and standard errors of the lambs on the 30th, 60th, 90th, 120th, 150th, and 180th days are given. According to the GLM analysis results, sex significantly influenced lactation length ($p<0.05$), and there was a difference in favor of female lambs. The impact of dam age was notably significant on live weight at days 60 and 90 ($p<0.05$). Additionally, birth type significantly affected live weight at day 30 and 60 ($p<0.001$), as well as at day 90 ($p<0.01$). Regarding the linear relationship between dam weight and live weight, a significant effect was observed at day 30 ($p<0.001$), day 60 ($p<0.01$), and day 90 ($p<0.05$). Notably, the linear effects of lamb birth weight on live weight remained significant across all control periods ($p<0.001$).

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1. Introduction

Norduz sheep are bred in the Gürpınar district (Van, Türkiye). They are white, ash, gray, and brown–white in color. Black spots can be found on the head, feet, and chest, particularly. Half of the ewes and most of the rams are horned. The sheep are combined productive. The sheep have a high-built body and are a fat-tailed breed (Anonymous, 2022a and 2022b; Çelikyürek, 2023). Norduz sheep are a newly registered sheep breed. There are very few studies on this breed of sheep. Studies are needed to determine the morphological, physiological, and other breed characteristics of these sheep breeds, which have 13 pairs of ribs (Çelikyürek, 2022).

The study focused on determining the live weights of Norduz lambs up to the 180th day, along with assessing lactation milk yield and lactation duration in Norduz sheep. The investigation aimed to uncover the impact of various factors including sheep lactation milk yield, lactation length, age, sex, birth type, dam weight, and lamb birth weight on the live weights of lambs.

Milk yield control determines how much milk an ewe gives in a day and during lactation. Milk yield controls can ensure that breeding candidates with good breeding value can be identified and that low-productive individuals in the flock can be identified and accurately culled so that the flock can be fed according to its actual performance level. Damage to the farm can be minimized by the early diagnosis and treatment of mastitis thanks to continuous controls (Şahin & Akmaz, 2004).

In current sheep farming, milk revenue is second only to lamb production. However, sheep milk is an important source of protein in terms of nutritional value and taste, despite little use in human daily life. With its high-fat content, sheep milk also has positive effects on physical development compared to goat and cow milk.

One of the most important features with economic value in sheep breeding is growth. Growth can be defined as the change that occurs in the weight and body dimensions of the living thing in a certain period of time (Eyduran et al., 2009; Yıldız et al., 2009; Kum et al., 2010). Changes in live weight and body measurements are directly related to meat production. Sheep meat production is directly related to the number of lambs produced per unit sheep and the meat production capabilities of lambs. Meat production capabilities of lambs can be defined by live weight and live weight increase rate (Karaca et al., 1990; Altın & Çelikyürek, 1996).

Since sheep are an important branch of animal husbandry in Turkey in terms of milk yield, many studies to determine milk yield have been conducted. However, there are almost no studies on Norduz sheep. Norduz sheep, as a breed, meet the region's milk and meat producers' requirements for regional sheep production and are well adapted to the specificities of the region. Norduz sheep are also an important potential resource in terms of their usability in the genetic breeding of livestock in the region.

2. Material and Methods

2.1. Animal materials

The study was conducted at the Agricultural Application and Research Enterprise in Van-Turkey in 2020. The sheep were mated using the natural method. The rams were always kept in the herd. Therefore, the birth of lambs began in February and continued until April. The sheep were kept in closed sheepfolds from November to May. This study included 61 Norduz ewes and 66 lambs. Twelve of the lambs were twins, and 54 lambs were singletons. The birth weights of lambs and ewes were taken using a 10-g scale within the first 24 hours after birth. On inspection days, the lambs were separated from their mothers at night. In the morning, they were weighed on empty stomachs. Live weights were weighed at 30-day intervals from birth to the 180th day. The interpolation method was used to determine the live weights of lambs born at certain intervals on the specified control days. Ewes were milked on the 30, 60, 90, 120, 150th, and 180th days, and milk yield was recorded. The milking process continued until the amount of milk obtained decreased to 0.10 ml. Ewes and their lambs were fed indoors for the first three months of the season and then grazed part-time on the pastureland of Van Yüzüncü Yıl University. In the sheepfold, dry-rough grass or silage feed is given to the sheep. Sheep are not given milk feed or fattening feed. The lambs were weaned at 90 days of age, on average.

2.2. Statistical analysis

The data underwent analysis through the least squares method and the general linear model procedure (GLM). Simple linear regression was employed to assess the impact of milk yield on days 30, 60, 90, 120, 150, and 180 on live weight. Pearson's correlation analysis was utilized to determine trait relationships, including the correlation between milk yield and body weight on each control day. Statistical analyses were conducted using R (2023) and SAS (2023) software programs.

2.3. Mathematical models

The lactation milk yield of ewes can be calculated using the Trapezoidal Method. Here's a general format of the formula used in such calculations:

$$X_{Trapez} = [(k_1.A) + \left(\frac{k_1+k_2}{2}\right).a_1 + \cdots + \left(\frac{k_{n-1}+k_n}{2}\right).(k_n.C)] \quad (1)$$

The following mathematical model was used for the milk yield.

$$MY_{ijk} = \mu + a_i + b_j + c_k + b_1(X_{1ijk} - \bar{X}_1) + b_2(X_{2ijk} - \bar{X}_2) + e_{ijk} \quad (2)$$

The following mathematical model was used for the live weight.

$$LW_{ijk} = \mu + a_i + b_j + c_k + b_1(X_{1ijk} - \bar{X}_1) + b_2(X_{2ijk} - \bar{X}_2) + e_{ijk} \quad (3)$$

3. Results and Discussion

The study was conducted in a sheepfold where sheep were housed in the winter and feeding was done indoors. In the sheepfold, dry-rough grass or silage feed is given to the sheep. Sheep are not given milk feed or fattening feed. Therefore, in this type of breeding system, sheep's milk (lactation milk yield; 53.934±2.31 l) is only enough to feed the lamb. It is thought that the milk obtained during milking is not enough to meet the labor and the workforce required for milking. However, according to the results of the literature reviewed, it was concluded that milking the milk obtained in rich pasture conditions together with lamb production could be economical. In such a breeding system, after the sheep's milk is milked, the remaining part is given to the lamb. As a result of this, the live weights of the lambs on the control days were found to be lower than the values in this study. After the lambs were taken to pasture, it was found that they closed this difference and had a higher average body weight.

3.1. Milk yield of Norduz ewes

The results of the data obtained are given in Table 1. Accordingly, 30, 60, 90, 90, 120, 150, and 180^{th} day's average milk yields were 0.315±0.02, 0.465±0.02, 0.310±0.02, 0.232±0.01, 0.228±0.02 and 0.079±0.01 *l*, respectively. As per the trapezoidal calculation method (Berger & Thomas, 2013; Kaymakçı, 2013), the average lactation milk yield was 53.934±2.31 *l*. The lactation length was 178.24±1.24 days. From the results above, we see that the milk yield of sheep increased from the 30^{th} to the 60^{th} day and then decreased, and this decrease continued until the 180^{th} day.

Bingöl (1998) determined a lactation milk yield of 132.78±2.70 *l* and a lactation length of 183.37±1.34 days in Norduz sheep. Yılmaz et al. (2004) determined lactation milk yield and lactation length of 125.09±0.93 *l* and 179.17±0.80 days, respectively, and Ocak (2009) 137.24±2.74 *l* and 182.55±1.33 days, respectively. Koncagül et al. (2012) determined a lactation milk yield of 130.9±3.24 *l*. The values obtained in these studies were higher than those obtained in this study, especially in terms of lactation milk yield. One of the main reasons for this difference is that the studies were conducted in village conditions and, in addition, the sheep were grazed in meadows and pastures with rich vegetation. Another reason could be that an adequate care and feeding program is not implemented for the sheep in the farm.

The lactation milk yield and lactation duration were 395.92 *l* and 185.01 days in Sönmez elite sheep (Kaymakçı et al., 2002), 98.92±3.85 *l* and 180.26±4.06 days in Kıvırcık sheep (Alarslan and Aygün, 2019) and 96.41±3.466 *l* and 198.76±0.981 days in Akkaraman crossbred sheep (Aşkan and Aygün, 2020). It was found that the obtained values were higher than the lactation milk yield and lactation duration in the study.

Lactation milk yield and lactation duration were 62.32±5.76 *l* and 173.3±10.7 days in Akkaraman sheep (Altın, 2001), 110.05 *l* and 165.46 days in Ivesi sheep (Gürsu & Aygün, 2014), 65.5±5.3 *l* and 167.9±7.4 days in Karakaş sheep (Altın & Çelikyürek, 1996), 103.08±3.354 *l* and 168.01±2.868 days in Karya sheep (Bayar, 2015), 192.76 *l* and 152.20 days in sheep grass flocks (Kaymakçı et al., 2002), 123.96 *l* and 158.65 days in Sakız x Akkaraman (F1) crosses (Esen & Özbey, 2002). These values were higher than lactation milk yield but lower in relation to lactation duration.

In terms of lactation milk yield and lactation duration, 50.65±6.36 *l* and 144.8±11.86 days were obtained for Hamdani x Akkaraman (F1) crosses (Altın, 2001), 56.9±7.4 *l* and 147.8±10.3 days for

Hamdani x Karakaş crosses (Altın & Çelikyürek, 1996). These values were lower than the values in this study.

The effects of dam age, birth type, and sex on milk yield in all control days and lactation milk yield were not significant in Norduz sheep ($p>0.05$). As a result of the analysis, it was found that dam age and type of birth had an insignificant effect ($p>0.05$), while sex had a significant effect ($p<0.05$) on lactation length. According to the results, the effect of sex was significant ($p<0.05$) in favor of female lambs. While this result supports this study, Bingöl (1998) reported in their study on Norduz ewes that the influence of dam age and birth type on lactation length was not significant but that dam age had a significant effect on lactation milk yield ($p<0.05$).

In a study conducted by Yılmaz et al. (2004) on Norduz sheep, it was reported that the effects of dam age and parturition type were significant ($p<0.001$). Koncagül et al. (2012) reported that the effect of dam age on milk yield in lactation was significant, while the effect of lamb birth type was insignificant in Norduz sheep. The linear effects ($p>0.05$) of ewe and lamb weights at birth on milk yield as determined on control days were found to be insignificant (except for the 60th day).

Table 1. Factors affecting the milk yield of sheep in various periods, lactation milk yield, and lactation length (*l*)

Factors		**n**	**30thday** ($\bar{X} \pm S_{\bar{X}}$)	**60thday** ($\bar{X} \pm S_{\bar{X}}$)	**90thday** ($\bar{X} \pm S_{\bar{X}}$)	**120thday** ($\bar{X} \pm S_{\bar{X}}$)	**150thday** ($\bar{X} \pm S_{\bar{X}}$)	**180thday** ($\bar{X} \pm S_{\bar{X}}$)	**Lactation m.y.** ($\bar{X} \pm S_{\bar{X}}$)	**Lactation length (*day*)** ($\bar{X} \pm S_{\bar{X}}$)
Means		**66**	0.315±0.02	0.465±0.02	0.310±0.02	0.232±0.01	0.228±0.02	0.079±0.01	53.934±2.31	178.24±1.24
Dam Age										
	2	**15**	0.303±0.06	0.485±0.05	0.305±0.05	0.201±0.03	0.187±0.04	0.040±0.03	50.562±5.85	179.84±3.06
	3	**28**	0.266±0.04	0.484±0.03	0.319±0.03	0.204±0.02	0.257±0.03	0.109±0.02	52.879±3.85	174.51±2.01
	4	**23**	0.333±0.05	0.385±0.04	0.306±0.04	0.230±0.03	0.219±0.04	0.089±0.02	52.021±4.89	178.75±2.55
Birth Type										
	Single	**54**	0.331±0.03	0.470±0.02	0.305±0.02	0.242±0.02	0.228±0.02	0.068±0.01	54.996±2.69	180.01±1.41
	Twin	**12**	0.270±0.06	0.433±0.05	0.315±0.05	0.181±0.04	0.214±0.04	0.091±0.03	48.645±6.11	175.39±3.19
Sex										*
	Male	**38**	0.290±0.04	0.471±0.03	0.320±0.03	0.216±0.02	0.190±0.03	0.082±0.02	50.897±3.86	174.88±2.02
	Female	**28**	0.312±0.04	0.431±0.04	0.301±0.03	0.208±0.02	0.252±0.03	0.077±0.02	52.745±4.23	180.52±2.21
Regression (*Lin.*)										
	Dam Weight at birth		0.003±0.00	0.006±0.00*	0.003±0.00	0.004±0.00	0.002±0.00	0.000±0.00	0.624±0.33	0.156±0.17
	Lamb Birth Weight		0.043±0.03	-0.01±0.02	0.010±0.02	0.000±0.02	0.010±0.02	0.015±0.01	2.883±2.79	0.133±1.46

$\bar{X}$ = Means, $S_{\bar{x}}$ = Standard error, ($p<0.05$): *.

3.2. Live weights of Norduz lambs on control days

The results of the data obtained are given in Table 2. Accordingly, live weights of 11.663±0.25, 17.342±0.36, 24.635±0.52, 31.999±0.64, 34.482±0.70, and 36.225±0.79 *kg* were determined for the 30, 60, 90, 120, 150 and 180th day, respectively. In a study on Norduz lambs conducted by Bingöl (1998), the live weights obtained were higher than the values from day 30 to 120 (9.20±0.10, 14.58±0.26, 20.27±0.21 and 29.93±0.28 *kg*, respectively) but lower than the values from day 150 and 180 (37.44±027 and 40.92±0.28 *kg*, respectively). The reason for the lower values could be that the lambs were given 3 meals per day after weaning and grazed on pastures with rich flora.

The values obtained in the study were higher than the mean values for live weight on the 30, 60, 90, 120, 150th, and 180th day (10.99±1.15, 18.10±0.29, 22.09±0.41, 25.34±0.42, 29.19±0.47, and 32.23±0.47 *kg*, respectively) as determined by Yılmaz et al. (2018) in their study (Norduz lambs).

It was also higher than the values at 90th and 180th day (21.78±1.30 and 35.09±1.62 *kg*) obtained by Bingöl & Bingöl (2015) in their study on Hamdani lambs. It was higher than the values (60th day 13.42, 90th day 17.51, 120th day 23.35, 150th day 26.48, 180th day 28.69 *kg*) obtained by Altın & Çelikyürek (1996) in their study on Akkaraman and Akkaraman x Hamdani lambs. It goes without saying that the values (7.51±0.94, 10.84±1.36, 15.13±1.89, 19.91±2.49, 25.03±3.13, 30.09±3.76 *kg*) obtained by Bingöl & Aygün (2014) in their study on Karakaş lambs are much higher.

The analyses revealed that dam age had a significant effect ($p<0.05$) on live weight on the 60th and 90th days. On the other inspection days, the effect was insignificant ($p>0.05$). A significant effect of maternal age was found for live weight at days 60 and 90 (Bingöl et al, 2007; Sarı et al., 2013), as well as researchers who reported that there was no effect of maternal age on all study ages; Bingöl & Aygün (2014) (Karakaş lambs); Altın & Çelikyürek (1996) (Akkaraman and Hamdani x Akkaraman lambs); Yılmaz et al. (2017) (Norduz lambs); Bingöl & Bingöl (2015) (Hamdani lambs); Alarslan & Aygün (2019) (Kıvırcık lambs, out of birth weight).

It was determined that the linear effects of lamb birth weight on live weights in all inspection days were highly significant ($p<0.001$). The linear effects of the dam's weight at birth on the 30th, 60th, and 90th day live weights were ($p<0.001$), ($p<0.01$) and ($p<0.05$), respectively.

The influence of birth type on live weight was significantly pronounced ($p<0.001$) on the 30th and 60th days and remained significant ($p<0.01$) on the 90th day. Studies on Norduz lambs revealed the following impact of birth type on live weight:

Karakuş et al. (2009) (highly significant ($p<0.001$) on the 30th, 60th, and 90th days and significant ($p<0.01$) on the 120th, 150th, and 180th days; Demirel et al. (2004): significant ($p<0.001$); and Bingöl (1998): significant on all inspection days. Thus, the results obtained in our study are comparable with those of the abovementioned studies.

Furthermore, there have also been studies that have shown a correlation between live weight; Yılmaz et al. (2007) reported significant ($p<0.01$) on live weight of Norduz lambs on the 90th and 180th days, while Daşkıran et al. (2010) reported insignificant effect on live weight of Norduz lambs.

It was found that the effect of sex on the live weight of lambs on control days was insignificant ($p>0.05$). In studies conducted on lambs of the same breed, Karakuş et al. (2009) reported that the effect of sex on live weight was significant on the 30 and 60th day ($p<0.001$) and on the 90th, 120th, and 180th days. For the specific day it was significant ($p<0.01$), Daşkıran et al. (2010) reported that it was significant from birth to day 198, while Bingöl (1998) reported that it was significant on all control days ($p<0.01$). In the studies conducted on live weights in different periods, Ceyhan et al. (2007) found that the effect of sex on live weights of Kıvırcık, Gökçeada and Sakız lambs was significant in the fourth, sixth and twelfth months ($p<0.01$), Altın et al. (2003) found that the effect of sex on live weight of Kıvırcık and Karya type sheep was significant at day 103 ($p<0.05$) and day 117 ($p<0.01$), but was not significant at the other periods. The linear effects of lamb birth weight on live weight were found to be highly significant ($p<0.001$) on all inspection days in our study. The linear effects of sheep birth weight on live weight on the 30th, 60th, and 90th days were ($p<0.001$), ($p<0.01$), and ($p<0.05$), respectively.

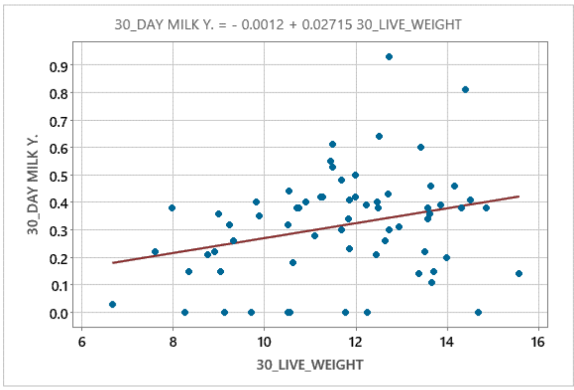
Table 2. Factors influencing on live weight of lambs on specified control days (kg)

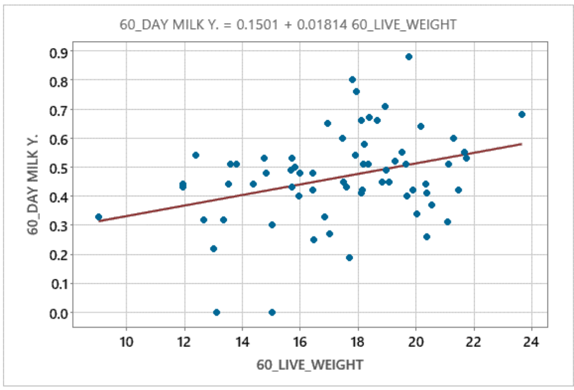
Factors	n	30th day ($\bar{X} \pm S_{\bar{X}}$)	60th day ($\bar{X} \pm S_{\bar{X}}$)	90th day ($\bar{X} \pm S_{\bar{X}}$)	120th day ($\bar{X} \pm S_{\bar{X}}$)	150th day ($\bar{X} \pm S_{\bar{X}}$)	180th day ($\bar{X} \pm S_{\bar{X}}$)
Means	**66**	11.663±0.25	17.342±0.36	24.635±0.52	31.999±0.64	34.482±0.70	36.225±0.79
Dam Age			*	*			
2	**15**	11.191±0.33	17.108±0.62[a]	24.627±0.98[a]	32.331±1.31	34.339±1.44	35.078±1.65
3	**28**	11.093±0.22	16.898±0.41[a]	24.173±0.65[a]	31.543±0.86	34.275±0.95	36.345±1.09
4	**23**	10.530±0.28	15.375±0.52[b]	21.872±0.82[b]	29.857±1.09	32.249±1.20	33.491±1.38
Birth Type		***	***	**			
Single	**54**	12.093±0.15	17.841±0.28	25.254±0.45	32.416±0.60	34.879±0.66	36.716±0.76
Twin	**12**	9.782±0.35	15.080±0.64	21.861±1.02	30.072±1.37	32.363±1.50	33.227±1.72
Sex							
Male	**38**	10.998±0.22	16.783±0.41	24.097±0.65	32.023±0.86	34.265±0.95	35.320±1.09
Female	**28**	10.878±0.24	16.138±0.45	23.017±0.71	30.465±0.95	32.977±1.04	34.623±1.19
Regression (*Lin.*)							
Dam Weight at Birth		0.071±0.02 ***	0.102±0.04 **	0.106±0.06 *	0.079±0.07	0.063±0.08	0.067±0.09
Lamb Birth Weight		1.384±0.16 ***	1.779±0.30 ***	2.339±0.47 ***	3.092±0.63 ***	3.577±0.69 ***	3.936±0.79 ***

a, b, c= Values within a row marked with different superscripts are significantly different at the following levels: *=(P<0.05), **=(P<0.01), and ***=(P<0.001). $\bar{X}$ = Means, $S_{\bar{x}}$ = Standard error.

3.3. Simple linear regression analysis to determine the effect of milk yield on live weight

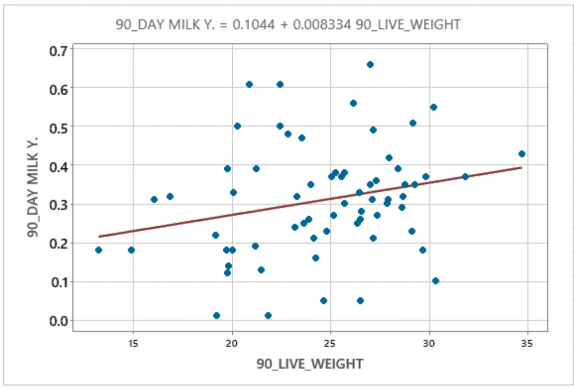
Simple linear regression analysis was performed to determine the effects of milk yields of ewes at 30, 60, 90, 120, 150th, and 180th inspection days on the live weights of their lambs (Figure 1). As can be seen from the graphs A, B, C, D, E, and F in Figure 1, the effects of milk yield on live weight were found to be positive and statistically significant ($p<0.05$). The highest contribution of ewes' milk yield to the live weight of lambs was found on the 30th day inspection. It is understood from the graphs that this effect gradually decreased until the 180th day.

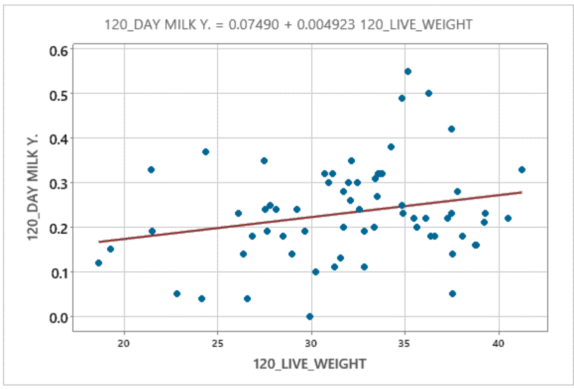




A: 30th DMY = -0.0012 + 0.02715 (30th LW)

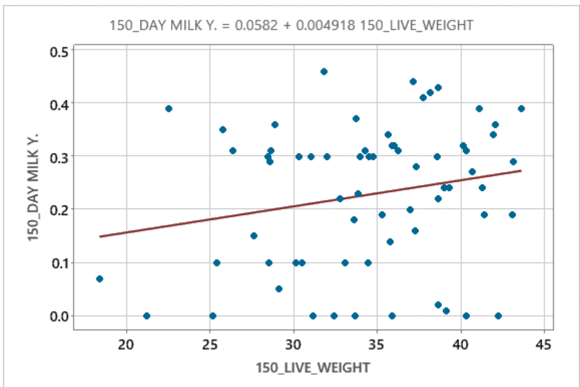
B: 60th DMY = 0.1501 + 0.01814 (60th LW)

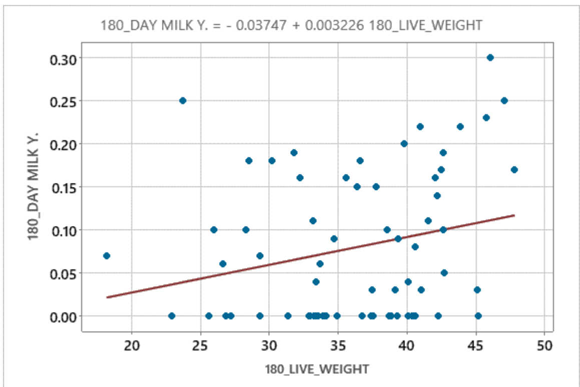




C: 90th DMY = 0.1044 + 0.008334 (90th LW)

D: 120th DMY = 0.07490 + 0.004923 (120th LW)





E: 150th DMY = 0.0582 + 0.004918 (150th LW)

F: 180th DMY = 0.03747 + 0.003226 (180th LW)

Figure 1. Simple linear regression analysis was used to evaluate the impact of milk yield on the live weight of Norduz lambs across different inspection days (Note: DMY: Daily Milk Yield, LW: Live Weight).

3.4. Correlation between all animal yields

Figure 2 illustrates a significant correlation between ewe live weight at birth and milk yield on the 90th, 120th, and 150th days. Moreover, the birth weight of the lamb shows a notable association with live weight on the 30th, 60th, 90th, 120th, 150th, and 180th days, contributing significantly to the overall live weight on control days.

Significant correlations were found between ewe milk yield on the 30th day and lamb live weight on the 30th and 120th days. Similarly, a significant correlation was observed between ewe milk yield on the 60th day and lamb live weight on the 60th, 90th, 120th, 150th, and 180th days. Furthermore, correlation tests indicated significant relationships between ewe milk yield on the 90th day and lamb live weight on the 90th day; ewe milk yield on the 120th day and lamb live weight on the 120th, 150th, and 180th days; and ewe milk yield on the 150th and 180th days and lamb live weight on the 90th and 180th days.

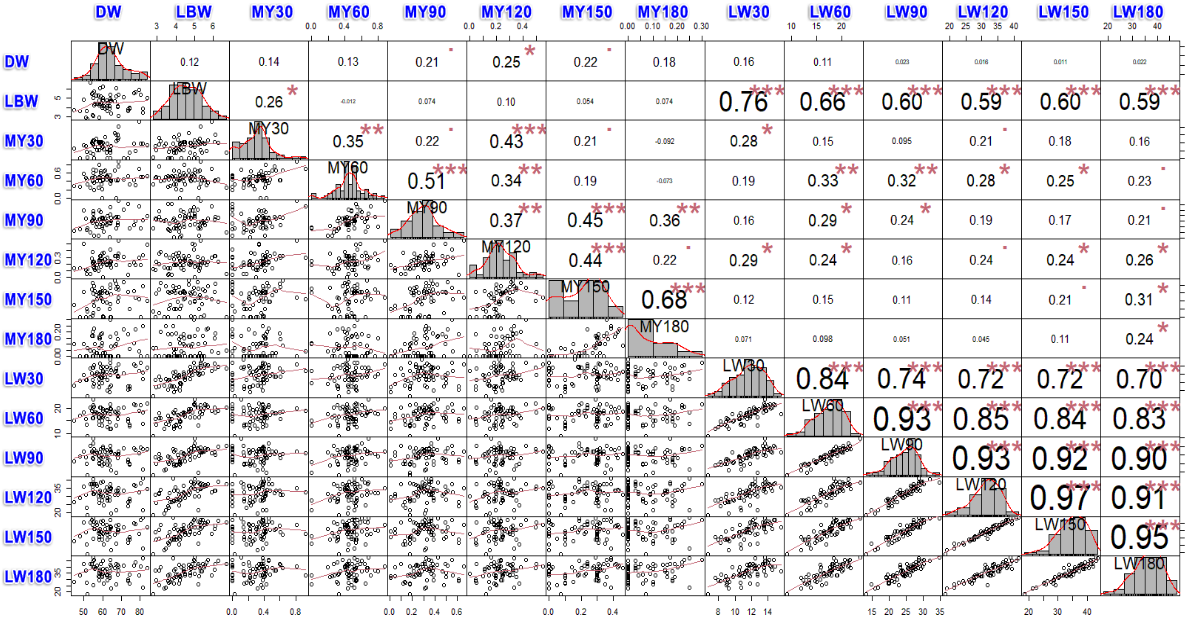


Figure 2. Pearson correlation coefficients of the factors affecting milk yield of Norduz ewes and the live weight of their lambs in different control days (DW: Dam weight, LBW: Lamb birth weight, LW: Live weight, MY: Milk yield, (p<0.05);* (p<0.01);** (p<0.001);***).

Figure 2 displays the correlation values as follows: between milk yield on the 30th day and live weight on the 30th day (r=0.28, p<0.05), between milk yield on the 60th day and live weight on the 60th day (r=0.33, p<0.01), between milk yield on the 90th day and live weight on the 90th day (r=0.24, p<0.05), between milk yield on the 120th day and live weight on the 120th day (r=0.24, p<0.05), between milk yield on the 150th day and live weight on the 150th day (r=0.21, p<0.05), and between milk yield on the 180th day and live weight on the 180th day (r=0.24, p<0.05). Analysis of these results reveals that the influence of ewe milk yield on lamb live weight increases progressively from birth and reaches its peak on the 60th day. This increase could be attributed to the lambs being weaned by the 90th day and subsequently being separated from the ewes, leading to distinct grazing patterns.

Conclusion

The study was conducted in a sheepfold where sheep were housed in the winter and feeding was done indoors. In the sheepfold, dry-rough grass or silage feed is given to the sheep. Sheep are not given milk feed or fattening feed. Therefore, in this type of breeding system, sheep's milk (lactation milk yield; 53.934±2.31 l) is only enough to feed the lamb. It is thought that the milk obtained during milking is not enough to meet the labor and the workforce required for milking. However, according to the results of the literature reviewed, it was concluded that milking the milk obtained in rich pasture conditions together with lamb production could be economical. In such a breeding system, after the sheep's milk is milked, the remaining part is given to the lamb. As a result of this, the live weights of the lambs on the control days were found to be lower than the values in this study. After the lambs were taken to pasture, it was found that they closed this difference and had a higher average body weight.

Through a simple linear regression analysis of the dams' milk yield on the live weight on control days as determined in the research, it was found that the milk yield of the dams had a positive and statistically significant effect on the live weights of the lambs ($p < 0.05$).

The correlation analysis between yields reveals a significant positive relationship between the birth weight of lambs and their live weights across all age periods. Additionally, the correlation table indicates a significant relationship between the average milk yield on milk inspection days and the live weights of the lambs at various inspection ages.

According to the GLM results of the data obtained in the study, it is seen that the effect of factors such as dam age, birth type, and sex of the lambs on milk yield in Norduz sheep is generally not statistically significant. Statistical analysis indicates that dam age significantly affects the live weight of lambs on the 60th and 90th days. Furthermore, the linear effect of birth type and dam weight consistently decreases until the 90th day from birth, as observed through statistical analysis. Notably, the linear effect of the live weight of the lamb at birth on the live weight at other ages remains significant ($p<0.001$).

In conclusion, it was determined that milk yield had a significant positive impact on the live weights of lambs in Norduz ewes bred under a sheepfold system without additional milk or fattening feed. Additionally, the birth weight of lambs showed a significant effect on their live weights at other ages.

Ethical Statement

The study was approved by the Republic of Turkey Ministry of Agriculture and Forestry, Van Directorate of Provincial Agriculture and Forestry, under permission number E-44762815-325.04.02[325.04.02]-3175480, indicating that it falls within the scope of a study not requiring ethics committee approval.

Conflict of Interest

The Authors declares that there are no conflicts of interest.

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Author Contributions

The first author designed the project and conducted official correspondence and interviews with support departments. The second author assisted the first author in data collection and helped to determine the methodology of the study. The first author tabulated the statistical analysis of the study, followed the official procedures and wrote the first version of the manuscript. The first author sent the manuscript to the second author for checking. After checks and corrections, it was uploaded to the journal.

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