Methods of estimating lactation milk yield by using control day yields in Awassi sheep

Research Article

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ABSTRACT

The objective of this study was to determine the effect of various milk control methods on prediction accuracy of lactation milk yield for Awassi sheep. Different control methods (Sweden, Vogel, Holland I, Holland II, Trapeze I, Trapeze II and State Production Farm methods) and control periods (14th, 21st, 28th, 42nd and 56th day) used to determine lactation milk yield were compared. The data of the research was created within the scope of the "National Project of Small Ruminant Animal Breeding in the Hands of the People" in 2018 and a total of 3173 sheep records belonging to 31 enterprises were used. The actual lactation yield in the study was determined as 255.57±0.85 kg and the lactation length as 170.62±0.19 day. Correlation coefficients between the actual lactation yield and lactation yield calculated according to different control methods were found to be high and significant for all control periods and control methods (P<0.05, P<0.01, P<0.001). It gave the similar results to the actual lactation yield in the Vogel method calculated according to different control methods in a period of 28th days, in the Trapeze I method in a period of 28th and 42nd days, in the Trapeze II method in all periods (P>0.05). In the other control periods, all methods differed significantly from the actual lactation yield (P<0.05, P<0.01, P<0.001). As a result, it has been concluded that results close to the actual lactation yield will be obtained by using one of the Vogel or Trapeze I-II methods calculated by using the milk yields on the control day of Awassi sheep raised under Şanlıurfa conditions.

Keywords: Awassi, control methods, control periods, lactation milk yield, test day.

INTRODUCTION

Success in animal breeding studies is possible by estimating the breeding value accurately and without deviation. It is necessary to determine the lactation milk yield (LMY) of sheep in order to calculate the breeding values and to make an effective selection. There is a significant variation between individuals in terms of LMY. Yield controls allow determination of LMY. Thanks to the yield controls, accurate and reliable information can be obtained about the quality and quantity of the production (Thomas et al., 2014). Estimating a sheep's breeding value is both costly and time consuming. The determination of the actual lactation yield (ALY) is possible by measuring and recording the milk obtained every day and every milking during the LL. This process is not both economical and practical for enterprises. For this purpose, different calculation methods have been developed to determine the LMY, giving results close to the ALY. Research in recent years have been concentrated on methods of estimating LMY from control day yields (Angeles-Hernandez et al., 2013, Mc Gill et al.,2014).

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The first studies to develop methods that take control periods into account in the calculation of LMY began in Denmark. Here in 1895 the first official "Yield Control Society" was established. Thanks to these studies, positive results have been obtained in increasing milk production.

The first five countries in the world with the larger sheep milk production are China, Turkey, Syria, Greece and Romania. Awassi sheep has a 3.5% portion in the world sheep population. Ewe's milk production in Turkey is about 1.4 million ton, according to data from 2018. Average LMY per sheep milked is 77 kg (FAO,2019; Skapetas and Kalaitzidou,2017; Talafha and Ababneh,2011; TUIK,2021).

For the calculation of these yields, milk production is generally monitored at average intervals of 30 days. The yield obtained from an animal on each test-day is called the 'test day' yield (Tonhati,2004). Using test-day yields instead of increasing yield records is an alternative to analyze problems. The main advantage of this approach is the possibility of reducing the number of test-day, thus reducing the generation interval (Ptak and Schaeffer,1993). Different methods have been developed to calculate LMY reported by ICAR. One of these methods is the test interval method (TIM). Different control methods used in the calculation of LMY (Sweden, Vogel, Holland I, Holland II, Trapeze I, Trapeze II, SPF etc.) and control periods (7th, 14th, 21st, 28th, 42nd, 56th day or monthly, bimonthly such as quarterly) has been developed. Average daily milk yield (ADMY) is calculated with the help of control day yields. This value is multiplied by the LL and LMY is obtained. Thus, with the correct calculation of the LMY, the control costs of the enterprises will decrease (Everett and Carter,1968).

Some authors have focused on finding mathematical models that describe the biological processes of milk production by mammary gland cells (Elvira et al.,2013; Pollott,2000). There are also researchers who recommend a statistical approach by modeling the shape of the lactation curve such as random regression test-day models (Brito et al.,2017; Mucha et al.,2014).

Awassi sheep is known as a very popular and proliferative breed in the non-European region due to its ability to absorb the environmental deviation. This study was carried out in order to reveal the most appropriate control method and control period to be used in estimating the LMY of Awassi sheep raised in Şanlıurfa.

MATERIAL and METHOD

Location

Şanlıurfa is located at 37 49 '12 "- 40 10' 00" east longitude and 36 41 '28 "- 37 57' 50" north latitudes in the Southeastern Anatolia Region of Turkey. It has elevation of 546.85 meters above sea level.

Data

The animal material of the study consists of sheep that are included in the "Small Ruminant Animal Breeding National Project in the Hands of the People". The data used in this study consisted of 3173 Awassi sheep and 3263 lambs raised in 31 family farms. The study was conducted in the 2018 breeding season. This study has been prepared from the project (TAGEM / 63IVE2017-03) supported by TAGEM.

Milk Yield Controls

Milk yield controls were done by hand milking method. Milk yield measurements were started on the 7th day of lactation. Milking was continued until the daily milk yield decreased to 50 ml. The amount of milk milked was accepted as the daily milk amount of the sheep.

The data for the lactation curves at 14th, 21st, 28th, 42nd and 56th days were calculated by interpolation and extrapolation methods.

The lambs were separated from their mothers one day before the control day and were not breastfed on the control day. The lambs were separated from their mothers at least 12 hours before the control time in order not to adversely affect the reliability of milk control. The lambs were separated from their mothers from 20:00 on the control day. The lambs were placed in a different section than the sheep for 24 hours. The amount of milk was measured with a measuring cylinder sensitive to 5 ml. The maximum daily milk yield is the highest daily yield obtained during control days. ADMY was obtained by dividing the total amount of milk obtained in the controls by the number of controls.

Control methods

Daily milk yield of sheep was determined by milking twice a day, in the morning and in the evening. ALY were obtained by collecting daily milk yields. Control period taking into consideration four widely used in international Sweden, Vogel, Netherlands I and Trapeze II methods, both of the Netherlands II, Trapeze II methods and LMY with State Production Farm (SPF) method developed in Turkey calculated and compared results. In the calculation of LMY were used at 14th, 21st, 28th, 42nd and 56th days intervals as control periods.

These control methods:

The Swedish method

The yield determined on the control day is accepted as the ADMY within that period. The quantity of milk in the period is calculated by multiplying the yield on the control day and the number of days in the control interval. The LMY is calculated by collecting the controls made separately for each period. The calculation formula for the Swedish method is as follows:

$$LMY= a \, . \sum_{i}^{n} k_i - \left(\frac{a}{2} - A\right).k_1$$

The Vogel method

The sum of the yields determined on the control days is multiplied by the control interval and the LMY is calculated. It can be applied in cases where the date of birth of the animal is unknown. It is a method with low sensitivity and is preferred for control yields with a low number. LMY calculation formula for Vogel method is as follows:

$$LMY= a \, . \sum_{i}^{n} k_i$$

The Netherlands I method

The Dutch I method is a practical way to use when control intervals are unequal. The yields determined on the control day are collected and divided by the number of controls milking. The value obtained is considered as the daily milk yield. The calculated daily milk yield is multiplied by the LL and LMY is obtained. As the time between birth and first control gets longer, the error increases. The LMY calculation formula for the Netherlands I-II method is as follows:

$$LMY = \left(\sum_{i}^{n} k_i \, / \sum n\right). LL$$

The Netherlands II method

$$LMY = \left(\sum_{i}^{n} k_i \, / \sum n\right). LL$$

The Trapeze I method

The Trapeze method is similar to the Swedish method in terms of calculation method. The efficiency of the period is calculated by multiplying the average of the data detected at the beginning and end of each control period by the number of days in that period. In the Trapeze I method, milk yield between the last control day and drying is not taken into account.

The LMY calculation formula for the Trapeze I method is as follows:

$$LMY = (A-1).k_1 + \frac{a}{2}(k_1 + k_n + 2(k_2 + k_3 + ...+ k_{n-1}))$$

The Trapeze II method

The LMY calculation formula according to ICAR is as follows:

$$LMY = (A-1).k_1 + \frac{a}{2}(k_1 + k_n + 2(k_2 + k_3 + ...+ k_{n-1})) + Bk_n$$

The SPF method

If the control number (n) is single in the SPF method:

$$LMY = (A-1).k_1 + a.(k_1 + k_2 + k_3 + k_4 + ...+ k_{n-1})) + Bk_n$$

If the control number (n) is double in the SPF method:

$$LMY = (A-1).k_1 + a.(k_1 + k_2 + k_3 + k_4 + ...+ (k_{n-1} + k_n)/2) + Bk_n$$

Description of the abbreviations used in the formula of the above methods:

LMY: lactation milk yield (kg),

LL: lactation length (day),

ADMY: average daily milk yield (g),

A: time between birth and first control (day),

B: time between the last control and the end of lactation (day),

C: time between the last control day and the dry period (day),

n: control number,

a: control period (day),

k_i: milk yield determined in any control (kg),

k_1:milk yield determined at the first control (kg),

k_n: milk yield determined in the final control (kg).

The relationship between LMY and control day yield was determined by calculating the ratio of the total monthly milk yields on the control day to the milk yield on each control day.

Statistical analysis

Control efficiencies were calculated by formulating the data with the help of Microsoft Office 2010 Excel programme. Statistical analyses were performed using statistical programme MINITAB (MINITAB,2005). Data were obtained by repeated measurements on sheep and analyzed using Least Squares mean method.

The absolute differences (| D | * 100 / ALY) were determined by calculating the arithmetic mean of the differences between ALY and LMY (D = (ALY-LMY) / N) and the standard deviation (SD) of the differences.

Correlation analysis was done relationships between control method and control period. The relationship between LMY calculated according to control methods was determined by a correlation analysis. Duncan was used for intergroup comparisons, and t test was used for intergroup comparisons in interaction tables.

RESULTS

This study was carried out with 3173 sheep from Awassi sheep breed raised in Şanlıurfa. After the birth of the lambs, a control milk yield was done according to the Trapeze II method by ICAR. It was determined that the studied sheep had an average of 265.68±0.39 kg milk for the 170.62±0.19 days of LL. The ALY in the study was determined as 255.57±0.85 kg and the LL as 183.41±0.57 days.

Monthly test-day milk yield means varied according to the phase of lactation, with the highest production being recorded for the second month of lactation, followed by a gradual decrease through to the tenth month. The increase in milk yield was 7.80% from the first to the second month, corresponding to a milk yield of 0.55 kg. The observed decline after the 2nd test day was calculated to be 7.09%. A minimal decline in percentage of production was observed from the second to the third month (4.48%), while the largest decrease (9.82%) occurred between the eighth and ninth month of test. These results support the recommendation from ICAR for using milk yield adjusted for 270th day of lactation.

In absolute terms, the average monthly decline in milk yield was 0.42 kg from the lactation peak. The largest decrease (0.52 kg) was observed from the fourth to the fifth test-day, while the smallest decrease (0.30 kg) occurred between the ninth and tenth test-day. The percentage and absolute total losses in milk yield from the second to the tenth test-day were 44.46% and 3.39 kg, respectively.

The distribution of LMY calculated in this study according to the number of sheep is given in figure 1. According to this figure, the highest number of sheep (980 sheep) gave milk between 261-270 kg, while the least number of sheep (6 sheep) gave 210-220 kg milk.

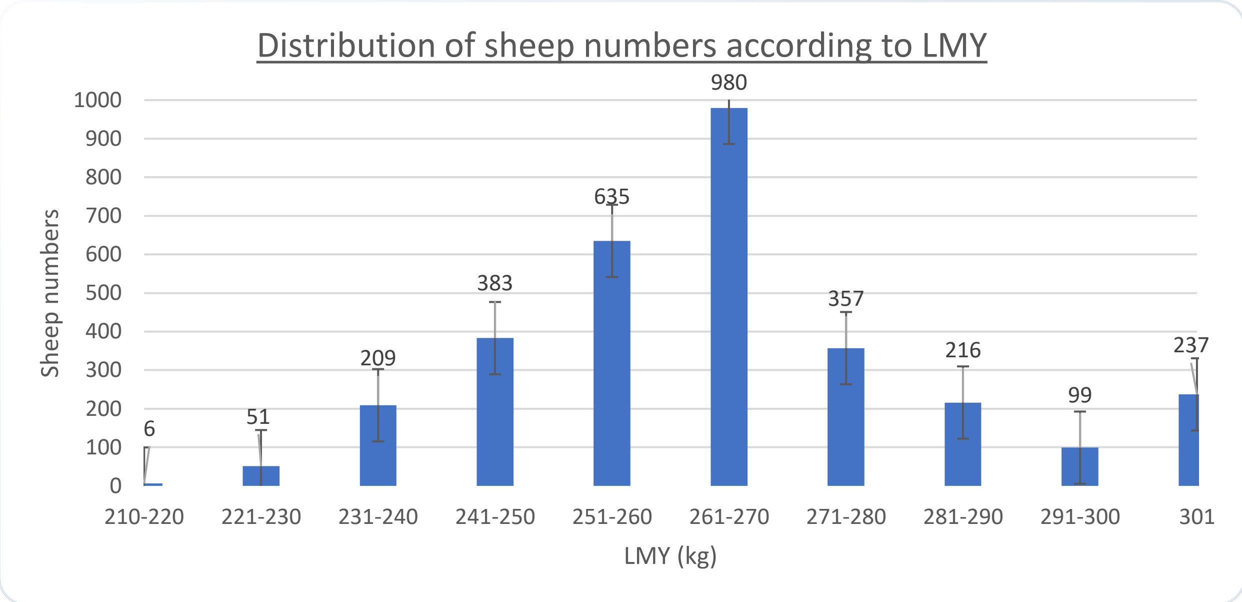

Figure 1. Distribution of sheep numbers according to LMY.

In this study, it was determined that the estimation error increased significantly (P<0.01) as the time between inspections increased. The effect of the calculation method on the estimation error was found to be significant (P<0.01) and it was determined that the Trapeze II method predicted the yield more accurately.

Correlation values between ALY and estimated yields were found to be very high and significant (P<0.01). Therefore, if the aim is to rank sheep according to their yield level, any combination of calculations examined in the study can be used. However, if it is desired to estimate the yield closest to the ALY, the inspection interval should be 28th day. In this case, the Dutch or Trapeze method can be used. If the inspection interval is 56th day, the yield should be estimated with the Trapeze method.

Arithmetic means of LMY calculated according to different control methods, mean of differences (D), SD values and % absolute difference values are given in Table 1.

According to Table 1, the lowest D value was observed in the 28th day control period of the Vogel method, the 28th to 42nd day control period of the Trapeze I method and the whole period of the Trapeze II method. These differences are statistically insignificant (P>0.05). LMY in other control periods differed significantly from ALY (P<0.05, P<0.01, P<0.001).

Table 1. Arithmetic means ($\bar{X}$) of LMY calculated according to control methods, mean of differences (D) and % absolute difference values.

CONTROL PERİOD (Day)		CONTROL METHOD						
		SWEDISH	VOGEL	HOLLAND I	HOLLAND II	TRAPEZE I	TRAPEZE II	SPF
14	$\bar{X}$	243.01	230.59	244.51	292.25	238.35	253.77	235.11
	D±SD	12.56±0.015	24.98±0.03	11.06±0.02	-36.68±0.05	17.22±0.03	1.80±0.01	20.46±0.07
	MF%		10	4	14	7	1	8
	P	*	***	*	***	**	-	**
21	$\bar{X}$	241.45	245.67	247.55	263.10	248.77	257.72	269.24
	D±SD	14.12±0.036	9.90±0.04	8.02±0.02	-7.53±0.05	6.80±0.01	-2.15±0.05	-13.67±0.07
	MF%		4	3	3	3	1	5
	P	**	*	**	-	-	-	*
28	$\bar{X}$	267.74	261.79	267.83	265.36	259.53	261.68	267.99
	D±SD	-12.17±0.025	-6.22±0.03	-12.23±0.09	-9.79±0.03	-3.96±0.04	-6.11±0.03	-12.42±0.07
	MF%		2	5	4	2	2	5
	P	*	-	*	*	-	-	*
42	$\bar{X}$	264.05	264.58	264.11	281.33	249.99	258.36	237.87
	D±SD	-8.48±0.04	-9.01±0.09	-8.53±0.02	-25.76±0.04	5.58±0.01	-2.79±0.05	17.70±0.01
	MF%	3	4	3	10	2	1	7
	P	-	*	-	***	-	-	**
56	$\bar{X}$	267.34	263.02	245.77	266.63	239.01	261.82	263.83
	D±SD	-11.77±0.03	-7.45±0.01	9.80±0.05	-11.06±0.03	16.56±0.03	-6.25±0.07	-8.26±0.02
	MF%	5	3	4	4	6	2	3
	P	*	-	*	*	**	-	-

*: P<0.05; **: P<0.01; ***: P<0.001; -: No significant; SD: Standart Deviation.

The results obtained in the present study indicate that adoption of test-day yields as selection criteria might contribute to greater genetic gain in LMY. The results show that test day milk yields are most closely related to total milk yield.

The results of the correlation coefficients between control methods and control periods are given in Table 2.

Table 2. Correlation coefficients between control methods and control periods.

Control Method	Control Period (day)				
	14	21	28	42	56
SWEDISH	0.93**	0.92**	0.95**	0.94**	0.93*
VOGEL	0.91**	0.90*	0.98***	0.91*	0.90*
HOLLAND I	0.95***	0.92**	0.95**	0.94**	0.92**
HOLLAND II	0.91**	0.89*	0.95**	0.96**	0.91*
TRAPEZE I	0.93***	0.92**	0.98***	0.97***	0.92**
TRAPEZE II	0.97***	0.96***	0.97***	0.98***	0.99***
SPF	0.97***	0.93**	0.95**	0.93**	0.90*

*: P<0.05; **: P<0.01; ***: P<0.001.

According to this table, the correlation coefficients between control methods and control periods were found to be positive and highly significant in all control methods and periods of Trapeze II (P<0.001).

Estimates of permanent environmental correlations were high, suggesting that both traits are affected in part by the same environmental factors.

DISCUSSION

In this study performed in Awassi sheep, the ALY was calculated as 255.57±0.85 kg and the lactation length as 170.62±0.19 days. Awassi sheep can produce an average of 60-80 liters milk with a LL of 150 days under different methods of production while an improved

Awassi sheep can yield 504 liters milk within 214 days of LL under a well-managed production system (Talafha and Ababneh,2011). Mavrogenis (1996) calculated the lactation milk yield between 109-133 liters in the first 90-day period in Awassi sheep. Reiad et al. (2010) calculated the average LMY of Awassi sheep in a flock obtained as 243.3 ± 3.96 kg at the Agricultural Scientific Research Centre in Salamieh / Syria. The LMY calculated in this study was found to be lower than the values of 359.3 and 345.1 kg in the Eastern Friesian and Lacaune breeds, respectively. LL was found to be similar with 188.6th and 180.3rd days in East Friesian and Lacaune breeds, respectively (Thomas et al.,2014).

The study by Panayotov et al. (2018) was carried out with 50 sheep from the Lacaune breed imported from France. During the testing of the milk yield was used the Method AC by ICAR. LMY were calculated by measuring the milk yields of each animal studied on five separate test days, once a month during the LL. It was established that the studied sheep had an average 213.29 L for the 150 days LL. The highest was the milk yield on the first test-day an average 2.279 L, with maximum deviation 3.310 L. A 77% of the ewes had a milk yield over 180 L, a relatively smaller part (6.5%) had a milk yield under 150 L, while 14.5% of the ewes had a milk yield over 270 L, and the maximum value was 298.38 L. Panayotov et al. (2018) reported in their study that 31.3% of sheep gave 180-210 kg of milk, while 6.3% of sheep gave less than 150 kg of milk.

Jawasreh and Khasawneh (2007) defined a study for the evaluation of genetic traits of milk yield in Awassi sheep at an agriculture research center in Amman, Jordon. The observed mean for total milk yield (kg) was 1,532.68 ± 660.88, which is similar to those reported by Tonhati et al. (2000). Basdagianni et al. (2018) evaluated some reference LL and finalized an appropriate LL for the Chios sheep breed. They used 24 474 dams from 130 herds for test days milk recording for a total of 260042 between 2003 and 2014.

Gootwine and Pollott (2000) had done a study in which he analyzed Awassi sheep's LMY for estimation of milk production factors and lactation curve parameters. The experimental flock was milked two times a day after lambing and reared under intensive management conditions. As a result of this study, the researchers reported that they achieved an average of 506 liters of total milk yield in a 214th day LL. The highest milk yield reached on the 45th day of lactation was 3.44 liter, and the maximum daily milk yield was 3.9 liters. Milk yield increased by 62 g / day from the first day of lactation to mid-lactation and decreased as 16.5 g / day from mid-lactation to the end of lactation.

Pollott and Gootwine (2000) reported that Awassi ewes peaked on the 27th day (3.34 liters) and showed a decrease in milk production of 15.3 g / day on the 150th day, giving a total of 543 liters of milk on the 280th day.

CONCLUSION

Enterprises should take 3 points into account when deciding for the control method and control period. It should be known how much loss the error made at the decision stage causes the enterprises. It should take account of the environmental conditions that changing over time. Milk should be taken exactly in all control days.

As a result, it has been concluded that results close to the actual lactation yield will be obtained by using one of the Vogel or Trapeze I-II methods calculated by using the milk yields on the control day of Awassi sheep raised under Şanlıurfa conditions.

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Conflict of interest: The authors declare that there is no conflict of interest for this article.

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