Lactation curve traits of Anatolian population of brown Swiss cows in turkey

S. Cilek[1†], I. Keskin[2], Fatma Ilhan[2], E. Hesna Sahin[3]

[1]*Kirikkale University, Faculty of Veterinary Medicine, Department of Animal Husbandry,*
[2] *Selcuk University, Faculty of Agriculture, Department of Animal Husbandry*
[3] *Afyon Kocatepe University, Faculty of Veterinary Medicine, Department of Animal Husbandry, 03200, Afyonkarahisar, Turkey Affiliation*

SUMMARY

This study was done to determine lactation curves traits of Brown Swiss cows in raised at Ulaş state farm, Sivas in Turkey (Middle Anatolia), belonging to the Ministry of Agriculture. Gamma curve parameters ($Y_t = At^b e^{-ct}$) of Wood (1967) in determination the shape and type of lactation curve were used. In lactation curves investigated in this study, percent of atypical lactations was found as 15.2 %, 15.5 %, 23.6 %, and 21.7 % for calving in winter, spring, summer, autumn, respectively (b and c of parameter are negative)

The least square means of beginning yield (a), coefficient of rising (b), coefficient of decreasing (c), coefficient of persistency (S), average maximum daily peak yield (Y_{max}) and the time after parturition when the peak yield occurs (T_{max}), coefficient of determination of variation (R^2) are 23.085±0.2773, 0.4192±0.0142, 0.1979±0.0044, 2.36±0.019, 21.97±0.257, 2.75±0.668, 74.73±0.59 for winter; 24.484±0.309, 0.3869±0.0143, 0.2088±0.0046, 2.228±0.0177, 21.771±0.2527, 2.33±0.7102, 78.06±0.60 for spring; 24.4353±0.3515, 0.2829±0.0155, 0.1757±0.0055, 2.3336757±0.0241, 21.64889±0.2940, 2.990427±0.9924, 75.72±0.72 for summer; 20.8659±0.2810, 0.3079±0.0153, 0.1518±0.0048, 2.587592305±0.0272, 0.963122382±4.4944, 19.55090832±0.2419, 68.59±0.77 for autumn, respectively.

Means of milk yield of cows with atypical lactation curve was found lower than means of milk yield of cows with typical lactation curve. Cows with atypical lactation curve might be culled. Selection might be conducted according to daughters of cows with typical lactation curve.

Keywords: cattle, Brown Swiss, lactation curve, persistency, milk yield, mathematical model

[†] suleymancilek@yahoo.com

INTRODUCTION

The milk yields of cows occur as the result of combined effects of genotype and environmental condition. Milk yield is generally standardized as milk produced in a 305 day, mature age and Milking frequency (Cilek and Tekin, 2006). Milk yield is increased until first 55 days during lactation, gets to peak and mount of milk produced daily decreases until the end of lactation (Cilek and Kaygisiz, 2008). This general trend of the curve formed by amount of test day milk yield during the lactation is also called lactation curve. Wood (1967) classified the lactation curves into two types, namely, flat lactation curves (relatively homogenous fluctuations), which are more advantageous than those of the second type, the steep lactation curves (no homogenous fluctuations). Describing lactation curves provides useful information for breeding programs and management practices, especially for culling and in assessing the nutritional and health status of animals. In order to assess plausible forms of lactation curves, milk yield records collected throughout the whole lactation are required (Chang et al., 2001; Mcgill et al., 2006).

The importance of the curve can be positioned in predicting the lactation yield by using both completed or part lactation length, depending on the method used to describe the underlying curve (Fadlelmoula et al., 2007). Most of lactation curve studies deal with average patterns of homogeneous groups of animals, even if individual curves are of interest for many practical purposes, e.g., health monitoring, individual feeding and genetic evaluations. Individual curve fitting in dairy cows results in a wide range of goodness of fit, due to the great random variation of shape among animals (Macciotta et al., 2006). The occurrence of atypical shapes, characterized by the absence of the lactation peak, occurs in about 25–42% (Kaygisiz, 1999; Orhan and Kaygisiz, 2002; Kaygisiz et al., 2003; Soysal et al., 2005)

This study was done to determine lactation curves traits of Brown Swiss cows in raised at Ulaş state farm, Sivas in Turkey (middle Anatolia), belonging to the Ministry of Agriculture.

MATERIAL AND METHODS

During the period from 1985 to 2000, at middle Anatolia in Turkey, Data on monthly test day milk yield records representing the first ten lactations of 3118 Brown Swiss cows were collected from a herd in the Ulaş state farm belonging to the Ministry of Agriculture. Total of 3118 lactation records were used in calculation (850 in winter, 856 in spring, 726 in summer, 686 in autumn. One non linear equation (Wood, 1967) was used in this study.

The mathematical expression of lactation curve is called biometry of lactation. Wood (1967) examined the daily milk yield variations. As the daily yield was the function of time; the proposed non-linear mathematical equations were as $Y_t = At^b e^{-ct}$.

Lactation curves contained the components of the coefficient of beginning yield (a), coefficient of rising (b), coefficient of decreasing (c), coefficient of persistency (S), average maximum daily peak yield (Y_{max}) and the time after parturition when the peak yield occurs (T_{max}). The independent and dependent variables of lactation curves given above are the time [is shown (n) or (t)] and the lactation yield in (n)- th day of lactation respectively. In the equations, the coefficients which may be derived directly from the model of lactation curves are the maximum daily yields. The time when maximum (peak) milk yield is attained. The persistency of lactation expresses the rate of decline (Orman and Okan, 1999; Keskin and Tozluca, 2004; Soysal et al., 2005; Aziz et al., 2006).

The persistency values were calculated by using the formula given below. S=[[-(1+b)][ln c]]or S=c(-b+1) The time required to reach peak yield (T_{max}) was estimated as the ratio (b/c). The peak yield (Y_{max}) was estimated using the following formula. Y_{max}=a(b/c)be-b Obtained curves were classified as a typical and an atypical according to the sign of parameters. The correlation coefficient (r) between the observed milk yield and predicted milk yield were calculated. According to the equations which were used for test day yield data correlation coefficient were also calculated. The squares of correlation coefficients (R^2) were used to compare the models. All statistical analysis techniques were conducted using SAS17 computer program (Soysal et al., 2005).

RESULTS AND DISCUSSION

The distribution of typical and atypical lactation curves according to season was presented in table 1. Effect of calving season were highly significant (P<0.01) on atypical lactation curves. Lactation curves were atypical, 15.18 % in winter, 15.54% in spring, 23.60% in summer, 21.70 % in autumn. The highest percent of atypical lactations was estimated in summer.

Table 1. The distribution of typical and atypical lactation curves according to season

Groups		Dispersal of atypical lactations			Number of typical curves	χ^2
Main group	Subgroup	B negative	B and C negative (concave)	Total		
Season	Winter	96	129	225 (26.47 %)	625 (73.53 %)	9.227
	Spring	97	133	230 (26.87 %)	626 (73.13 %)	7.823
	Summer	105	171	276 (38.02 %)	450 (61.98 %)	15.220
	Autumn	96	149	245 (35.71%)	441 (64.29 %)	6.210
Total		394	582	976 (31.30 %)	2142 (68.70 %)	38.481**

**: P< 0.01

The A, B, C, S, T_{max}, Y_{max}, R^2 values of material according to Wood model were calculated for each record. Then the average value of the constants of A, B, C, S, T_{max}, Y_{max}, R^2 and values were determined. The results were grouped according to the season of lactation. The results are given in table 2.

Coefficients of the determination of variation were found as 74.73±0.591, 78.06±0.60, 75.72±0.72, 68.59±0.77 for winter, spring, summer and autumn, respectively.

Table 2. The A, B, C, S, Tmax, Ymax, R2 values of material according to Wood model

Season		R^2	A	B	C	T_{max}	Y_{max}	Persistency
1	Mean	74.73	23.09	0.42	0.20	2.75	21.97	2.361
	Standard error	0.591	0.277	0.014	0.004	0.668	0.257	0.019
2	Mean	78.06	24.48	0.39	0.21	2.33	21.77	2.228
	Standard error	0.601	0.309	0.014	0.005	0.710	0.253	0.018
3	Mean	75.72	24.44	0.283	0.18	2.99	21.65	2.33
	Standard error	0.715	0.352	0.015	0.006	0.992	0.294	0.024
4	Mean	68.59	20.87	0.31	0.15	0.96	19.55	2.59
	Standard error	0.768	0.281	0.015	0.005	4.494	0.242	0.027

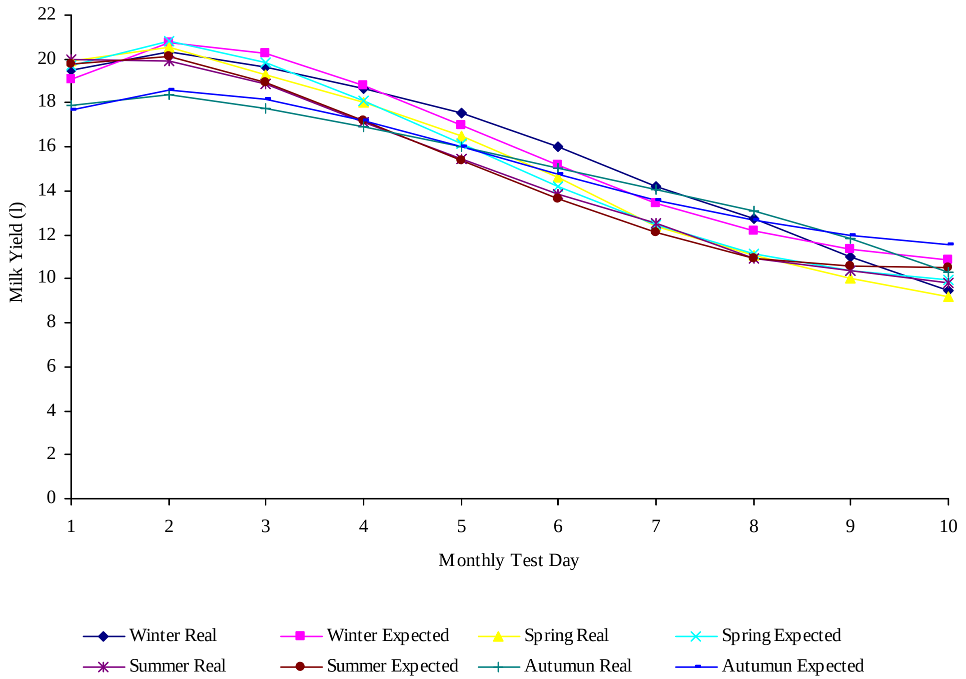

Figure 1. Real and expected lactation curves according to the season of starting lactation

The least square means of coefficient of persistency (S), average maximum daily peak yield (Y_{max}) and the time after parturition when the peak yield occurs (T_{max}) are 0.1979±0.0044, 2.36±0.019, 21.97±0.257, 2.75±0.668, for winter;

0.2088±0.0046, 2.228±0.0177, 21.771±0.2527, 2.33±0.7102 for spring; 0.1757±0.0055, 2.3336757±0.0241, 21.64889±0.2940, 2.990427±0.9924 for summer; 2.587592305±0.0272, 0.963122382±4.4944, 19.55090832±0.2419 for autumn, respectively.

Real and expected lactation curves according to season of starting lactation were presented in figure 1. Amount of expected milk yield and real daily milk yield according to season of entering lactation was presented in table 3. The highest test day milk yield was obtained in first three test day.

Table 3: Expected and real daily milk yield according to the season of entering lactation

Monthly Test Day	Season							
	Winter		Spring		Summer		Autumn	
	Real	Expected	Real	Expected	Real	Expected	Real	Expected
1	19.465	19.072	19.936	19.722	19.958	19.756	17.893	17.693
2	20.326	20.765	20.533	20.805	19.940	20.110	18.363	18.597
3	19.650	20.260	19.284	19.861	18.840	18.947	17.745	18.204
4	18.687	18.812	18.048	18.119	17.127	17.217	16.934	17.226
5	17.520	17.022	16.492	16.149	15.425	15.391	16.021	16.020
6	16.007	15.190	14.647	14.223	13.847	13.667	15.038	14.768
7	14.220	13.461	12.420	12.459	12.512	12.126	14.084	13.560
8	12.721	12.154	11.039	11.106	10.965	10.958	13.107	12.638
9	10.995	11.354	9.995	10.341	10.376	10.591	11.860	11.955
10	9.473	10.834	9.204	9.933	9.796	10.479	10.320	11.568

Expected and real daily milk yield according to season of entering lactation is presented in table 3. The highest test day milk yield was obtained in first tree test day.

Correlations between parameters of lactation curve and 305-day milk yield are presented in table 4. Correlations between parameters of lactation curve were significant statistically. However, correlations between parameters of lactation curve and 305 day milk yield were non significant statistically (P<0.01).

Table 4. Correlations between parameters of lactation curve and 305days milk yield.

	A	B	C	T_{max}	Y_{max}	Persistency (S)
B	0.126**					
C	0.338 **	0.867**				
T_{max}	0.007 ns	-0.007 ns	-0.009 ns			
Y_{max}	0.861 **	0.324 **	0.314**	-0.117**		
Persistency (S)	-0.376 **	-0.327 **	-0.723 **	-0.159**	-0.119**	
305- day Milk Yield	0.022 ns	0.018 ns	0.013 ns	-0.001 ns	0.031 ns	0.004 ns

**: P< 0.01, ns: non significant

305 day milk yields according to the types of lactation curve are presented in table 5.

Table 5. 305 days milk yields according to the types of lactation curve

Factor	N	$\overline{X} \pm S_{\overline{X}}$
Total	3118	4364±62.2
Types of lactation curve		**
Typical	2142	4430±84.17[a]
Atypical	976	4298±97.97[b]

a, b; Differences between means presented with different words in the same column is important statistically. **; P<0.01

Types of lactation curve on 305-day milk yield were statistically significant statistically (P<0.01). Means of milk yield of cows with atypical lactation curve was found 4298 kg. Means of milk yield of cows with typical lactation curve was found 4430 kg. Means of milk yield of cows with atypical lactation curve (4298 kg) was found lower 3 % than means of milk yield of cows with typical lactation curve (4430 kg).

The means of percent of 18.67 % of lactation curve were atypical. This rate was lower than Previous researches (Kaygısız, 1999; Orhan and Kaygısız, 2002; Kaygısız et al., 2003; Soysal et al., 2005). Effect of calving season were highly significant (P<0.01) on atypical lactation curves. Ratio of atypical lactation curve was highest entering in lactations in summer (23.6 %). Ratio of atypical lactation curve of calving cows in summer was found higher than lactation curves of calving cows in other seasons. This result was in accordance with the previous researches (Kaygısız 1999; Kaygısız et al., 2003).

Coefficient of determination were presented between 58.76 and 69.95 for Brown Swiss (Kaygısız et al., 2003), between 74.6 and 84.1 for Simmental (Kaygısız, 1999), between 50 and 63 for Holstein (Orhan and Kaygısız, 2002) and between 85 and 91 for Holstein (Soysal et al., 2005). In this study, coefficient of determination were found as 74.73±0.591, 78.06±0.60, 75.72±0.72, 68.59±0.77 for winter, spring, summer and autumn, respectively, these results were according to the previous researches (Kaygısız 1999; Orhan and Kaygısız, 2002; Kaygısız 2003; Soysal et al., 2005). It was said that determination of coefficient sufficiently explained variances of lactation curves.

The highest test day milk yield was obtained in first tree test day (Table 3). Daily milk yield decreased with the number of test day. The lowest test day milk yield was obtained in ninth test day. It was according to previous research (Çilek and Tekin, 2006).

Correlations between parameters of lactation curve (A, B, C, S, T_{max} and Y_{max}) and 305-day milk yield were non-significant statistically, according to with previous researcher (Kaygısız, 1997; Kaygısız, 1999). Correlations between A and T_{max} and correlations between A and S were significantly (P<0.01). If cows start lactation with high milk yield, maximum daily milk yield is high, however, persistency is lower. According to previous research (Kaygısız, 1999), Correlations between B and C and correlations between B and S were significant and high level ($P<0.01$).

Correlation between Y_{max} and T_{max} was significant and negative ($P<0.01$). Cows with high daily milk yield arrive to maximum daily milk yield early.

Types of lactation curve significant affected by 305 day milk yield ($P<0.01$). Means of milk yield of cows with atypical lactation curve (4298 kg) was found lower 3 % than means of milk yield of cows with typical lactation curve (4430 kg). Similarly, it was reported that milk yield of cows with atypical lactation curve was lower 5-6 % than means of milk yield of cows with typical lactation curve (Kaygısız, 1999; Yılmaz and Kaygısız, 2000).

CONCLUSIONS

In conclusion, means of milk yield of cows with atypical lactation curve was found lower than means of milk yield of cows with typical lactation curve. Cows with atypical lactation curve might be culled. Selection might be conducted according to daughters of cows with typical lactation curve.

REFERENCES

Aziz, M. A., Shalaby, N. A., El-Shafie, O. M., Mahdy, A. T., Nishida, A., 2006. Comparison between the shapes of lactation curve of Egyptian buffalo milk yield estimated by the incomplete gamma function and a new model. Livestock Research for Rural Development 18 (5) 2006.

Chang, Y. M., Rekaya, R., Gianola, D., Thomas, D. L., 2001. Genetic variation of lactation curves in dairy sheep: a Bayesian analysis of Wood’s function. Livest. Prod. Sci. 71: 241-251.

Cilek, S., Tekin, M.E., 2006. Calculation of Adjustment Factors for Standardizing Lactations to Mature Age and 305-Day and Estimation of Heritability and Repeatability of Standardized Milk Yield of Simmental Cattle Reared on Kazova State Farm. Turk J. Vet. Anim. Sci., 30; 283-289.

Cilek, S., Kaygısız, A., 2008. Breeding Value Estimation of Dairy Cattle Using Test Day Milk Yields For Brown Swiss Cows Reared At Ulaş State Farm. Journal of Veterinary and Animal Advance, 7 (6); in press.

Fadlelmoula, A. A., Yousif, I. A., Abu Nikhaila, A. M., 2007. Lactation Curve and Persistency of Crossbred Dairy Cows in the Sudan. Journal of Applied Sciences Research. 3(10): 1127-1133. 2007.

Kaygisiz, A.,1997. Comparison of the Lactation Curve Traits Simmental and Brown Swiss Cattle's in Raised in Altındere State Farm Hayvancılık Arastırma Dergisi, 7(1) : 25-30.

Kaygisiz, A., 1999. The Features of Lactation Curves of Yellow And White Cattle. Tr.J. of Veterinary Animal Science 23 No: 1-15-23. Ankara. Turkey.

Kaygisiz, A., Vanlı, Y., Yılmaz, I., 2003. A Study on Lactation Curve Traits of Brown Cattle, Hayvansal üretim 44(2):69-80.

Keskin, I., Tozluca, A., 2004. Describing of Different Mathematical Models For Lactation Curve And Estimation of Control Interval In Dairy Cattle. S.Ü. Ziraat Fakültesi Dergisi 18(34): 11-19.

Macciotta, N. P. P., Dimauro, C., Catillo, G., Coletta, A., Cappio-Borlino., A. 2006. Factors affecting individual lactation curve shape in Italian river buffaloes, Livestock Science 104; 33– 37

Mcgill, D., Fullard, K., Celi P., Thomson P. C., Hall, E., Iqbal A., Wynn P. C., Raadsma, H. W., 2006. Lactation Curve Characteristics And Persıstency of Lactation In Dairy Ewes Milked Once A Day: Preliminary Observations. Australian Society of Animal Production 26th Biennial Conference.

Orhan, H., Kaygısız, A., 2002. Siyah Alaca Sığırlarda Farklı Laktasyon Eğrisi Modellerinin Karşılaştırılması. Hayvansal Üretim 43(1): 94-99.

Orman, M. N., Ertuğrul, O., 1999. Holştayn İneklerin Süt Verimlerinde üç Farklı Laktasyon Modelinin İncelenmesi. Tr. J. of Veterinary and Animal Sci. 23: 605 - 614.

Soysal, M. I., Mutlu, F., Gurcan E. K., 2005. A Study of the Lactation Biometry of Black and White Daıry Cows Raised in Private Farms in Turkey Trakia Journal of Sciences. Vol. 3. No.6. 11-16.

Yilmaz, I., Kaygısız, A., 2000. Lactation Curve Traits of Holstein Cattle’s. Anakara Ün. Zir. Fak. Tarım Bilimleri Dergisi 6 (4) 1 - 10.

Wood, P. D. P., 1967. Algebraic model of the lactation curve in cattle. Nature 216: 164-165.