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DETERMINATION OF THE BEST NONLINEAR MODEL FOR DESCRIBING COMPLETE LACTATION OF AKKARAMAN AND GERMAN BLACKHEADED MUTTON X AKKARAMAN CROSSBREED (F_1) SHEEP

M. KUCUK[1] and E. EYDURAN[2]
[1] *University of Yuzuncu Yil, Department of Animal Science, Faculty of Veterinary Medicine, Van, Turkey*
[2] *Igdir University, Biometry Genetics Unit, Department of Animal Science, Faculty of Agriculture, 76000, Igdir, Turkey*

Abstract

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The fat-tailed Akkaraman breed, traditionally raised in Turkey, is a breed with the best adaptation to poor feeding and harsh conditions. German Blackheaded Mutton breed originated from British downs breeds, one of breeds raised in Germany, has long mating season (about approximately two lambs a year) and a perfect adaptation to rainy country. The objective of present paper was to determine the most appropriate nonlinear model for describing complete lactation of Akkaraman and German Blackheaded Mutton x Akkaraman B_1 Crossbreed Sheep. The data were consisted of milk production records collected from 25 Akkaraman (Genotype I) and 23 German Blackheaded Mutton x Akkaraman B_1 Crossbreed Sheep (Genotype II) with 2 year of age. Daily milk yields of all ewes were recorded fortnightly from 15^{th} days to 150^{th} days of lactation. Quadratic, Cubic model, and Wood models were fitted to daily milk yield – time data in order to explain daily milk yield-time relationship of these ewes. These models were fitted to averages of daily milk yield of all ewes at each period for two genotypes.

It was concluded that the best nonlinear model for describing complete lactation of Akkaraman breed and German Blackheaded Mutton x Akkaraman B_1 Crossbreed Sheep was found to be Cubic model.

Key words: Akkaraman, German Blackheaded Mutton, complete lactation, milk yield

Introduction

Milk yield, fertility, and health are the most vital characteristics that influence productivity of dairy production due to economic causes. Therefore, determination of the most suitable lactation model and their parameters provides useful information for realizing effective breeding program and appropriate management practices (assessing suitability of health and dietary conditions of ewes during lactation period) in increasing milk yield in dairy production (Ruiz et al., 2001; Dag et al., 2005; Keskin and Dag, 2006).

Besides, modeling lactation curves allows the assessment of genetic and environmental factors on components of milk production such as persistency, called the ability of an animal to sustain production beyond peak yield, influences on profitability of dairy production (Montaldo et al., 1997; Kamidi, 2005; Keskin and Dag, 2006). Wood, Inverse Polynomial, Quadratic and Cubic models are models commonly used in describing lactation curve (Keskin and Dag, 2006). There were numerous studies on determination of the most suitable lactation curve of different dairy cattle breeds in literature, but studies on lactation curves of all sheep breeds in Turkey and World were few. However, there was no published report on determination of the best lactation curve for German Blackheaded Mutton x Akkaraman Crossbreed (F_1) Sheep.

The present paper aimed to determine the best nonlinear model for describing lactation curve characteristics of Akkaraman and German Blackheaded Mutton x Akkaraman Crossbreed Sheep among Quadratic, Cubic model, and Wood models. The best nonlinear model might give an idea on determination of management problems and suitable feeding regimes on milk yield in a flock.

Materials and Methods

The data were consisted of milk production records collected from 25 Akkaraman (Genotype I) and 23 German Blackheaded Mutton x Akkaraman B_1 Crossbreed Sheep (Genotype II) with 2 years of age raised at Farm of Lalahan Research Institute, in Ankara, in Turkey. The fat-tailed Akkaraman breed, which is conventionally raised in Turkey, is a breed with the best adaptation to poor feeding and harsh conditions. German Blackheaded Mutton breed originated from British downs breeds, one of breeds raised in Germany, has long mating season (about approximately two lambs a year) and a perfect adaptation to rainy country.

All ewes lambed in March. They were hand milked twice daily. All lambs sucked their dams freely until first milk recordings. The lactating ewes were grazed from April to December and were kept and fed indoors throughout the winter.

The data were recorded fortnightly from 15th days to 150th days of lactation. Lactation curves on the data of daily milk yield (DMY) in lactation were evaluated using Quadratic, Cubic, and Wood nonlinear functions. These models were fitted to averages of daily milk yield at each period of ewes in two genotypes.

Equations of Quadratic, Qubic and Wood nonlinear functions can be calculated, respectively:

The Quadratic model: $Y_{(t)} = a + bt + ct^2$

The Cubic model: $Y_{(t)} = a + bt + ct^2 + dt^3$

The Wood model: $Y_{(t)} = at^b e^{(-ct)}$,

Where $Y_{(t)}$ is the milk yield at day t after lambing, e is the base of natural logarithm, a, b, c and d are the parameters which characterize the shape of the curve and which were estimated from a nonlinear regression analysis using the SPSS program (SPSS, 2008).

Coefficients of determination (R^2 %), Root Mean Square Error (RMSE) were used to determine the best nonlinear model. The best non-linear model had the highest R^2 (%), but the lowest RMSE value.

Persistency (P) was calculated as:

$$P\,(\%) = \frac{\sum_{i=1}^{k} (p_{i+1}) / p_i}{k} \times 100,$$

Where p_i is the yield of the record *i* that starts at peak time and *k* is the record number from peak time to the end of lactation (Keskin and Dag, 2006).

Results and Discussion

Table 1 presents parameter values, R^2 (%), RMSE and Persistency (%) values of Quadratic model fitted to daily milk yields of Akkaraman and German Blackheaded Mutton x Akkaraman B_1 Crossbreed Sheep in lactation. As seen from Table 1, each parameter values for two genotypes were highly significant. As shown in Table 1, when determination coefficient values of two genotypes were examined, quadratic model was found to be sufficient to explain variation of DMY-time data, but determination coef-

Table 1

Parameter values, R^2 (%), and RMSE values of Quadratic model for Akkaraman and German Blackheaded Mutton (GBM) x Akkaraman B_1 Crossbreed Sheep in lactation

Akkaraman breed		
Parameters	Estimate	Standard error
a	0.26137	0.02402
b	0.00683	0.00066882
c	-0.00005255	0.00000395
R^2 (%): 97.91	RMSE: 0.02042	Persistency (%): 68.29
GBM x Akkaraman Crossbreed		
a	0.42021	0.03745
b	0.00461	0.00104
c	-0.00004748	0.00000616
R^2 (%): 97.27	RMSE: 0.03184	Persistency (%): 66.29

Table 2

Parameter values, R^2 (%), and RMSE values of Cubic model for Akkaraman and German Blackheaded Mutton (GBM) x Akkaraman B_1 Crossbreed Sheep in lactation

Akkaraman breed		
Parameters	Estimate	Standard error
a	0.21011	0.03378
b	0.00986	0.00169
c	-0.00009635	0.00002321
d	$1.76995.10^{-7}$	$9.279347.10^{-8}$
R^2 (%): 98.70	RMSE: 0.01741	Persistency (%): 68.88
GBM x Akkaraman Crossbreed		
a	0.29315	0.01428
b	0.01213	0.00071369
c	-0.00015607	0.00000981
d	$4.387637.10^{-7}$	$3.92331. 10^{-8}$
R^2 (%): 99.87	RMSE: 0.00736	Persistency (%): 67.9

ficient for Akkaraman breed sheep (97.91 %) was found a little higher than that for German Blackheaded Mutton x Akkaraman B_1 Crossbreed Sheep(97.27 %). RMSE value calculated for Akkaraman breed sheep (0.02042) was found to be a little lower than that calculated for German Blackheaded Mutton x Akkaraman B_1 Crossbreed Sheep (0.03184). Persistency (%) values of Quadratic model for Akkaraman breed and German Blackheaded Mutton x Akkaraman B_1 Crossbreed Sheep were estimated as: 68.29 % and 66.29 %, respectively.

Table 2 presents parameter values, R^2 (%), and RMSE values of Cubic model fitted to daily milk yields of Akkaraman and German Blackheaded Mutton x Akkaraman B_1 Crossbreed Sheep in lactation. As seen from Table 2, when determination coefficients of

Table 3
Parameter values, R^2 (%), and RMSE values of Wood model for Akkaraman and German Blackheaded Mutton (GBM) x Akkaraman B_1 Crossbreed Sheep in lactation

Akkaraman breed		
Parameters	Estimate	Standard error
a	0.022	0.016
b	1 080	0.235
c	0.021	0.004
R^2 (%): 87	RMSE: 0.054772	Persistency (%): 77.06
GBM x Akkaraman Crossbreed		
a	0.036	0.020
b	1 032	0.188
c	0.025	0.003
R^2 (%): 94	RMSE: 0.044721	Persistency (%): 71.96

Cubic model were examined in two genotypes, the model was found to be fairly sufficient to explain lactation characteristics of two genotypes. RMSE values of Cubic model were found 0.01741 for Akkaraman breed and 0.00736 for GBM x Akkaraman crossbreed. Instead of quadratic model, the usage of Cubic model for two genotypes was resulted in increasing determination coefficients (R^2), but decreasing RMSE values, meaning that Cubic model was more superior to Quadratic model. Besides, since GBM x Akkaraman crossbreed had the highest determination coefficients (R^2), but the lowest RMSE value in Table 2, describing lactation characteristics of GBM x Akkaraman crossbreed using Cubic model was more advantageous than that of Akkaraman breed. Persistency (%) values of Cubic model for Akkaraman breed and German Blackheaded Mutton x Akkaraman B_1 Crossbreed Sheep were estimated as: 68.88 % and 67.90 %, respectively.

Table 3 presents parameter values, R^2 (%), and RMSE values of Wood model fitted to daily milk yields of Akkaraman and German Blackheaded Mutton (GBM) x Akkaraman B_1 Crossbreed Sheep in lactation. As seen from Table 3, when determination coefficients were observed, Wood model was sufficient to explain DMY-time data of two genotypes, but R^2 value of GBM x Akkaraman crossbreed (94 %) was found to be more sufficient than that of Akkaraman breed (87 %). RMSE value of Akkaraman breed sheep (0.054772) was found to be a little higher than that calculated for German Blackheaded Mutton x Akkaraman B_1 Crossbreed Sheep (0.044721). Persistency (%) values of Wood model for Akkaraman breed and German Blackheaded Mutton x Akkaraman B_1 Crossbreed Sheep were estimated as: 77.06 % and 71.96 %, respectively. Determination coefficients of the Cubic model were higher for two genotypes in the present paper than those of Quadratic and Wood models. RMSE values of the Cubic model for two genotypes were found to be lower than those of other models. Persistency values (%) of Wood model for two genotypes were estimated higher than those of other models. That is why; deviations among measured and predicted milk yields in Wood models were higher than those of other models.

Determination coefficients of Quadratic and Cubic models used for two genotypes in the present paper were found to be higher than those reported by some authors (Dag et al., 2005; Keskin and Dag, 2006).

Determination coefficients of Wood model for two genotypes in the present paper were found to be higher than those of some authors (Esenbuga and Bilgin, 2004; Dag et al., 2005; Keskin and Dag, 2006). The finding on Wood model was in agreement with those reported by some authors, who reported that Wood model was not an appropriate model for dairy sheep under grazing conditions (Dag et al., 2005; Esenbuga and Bilgin, 2004; Ruiz et al., 2000).

Conclusion

The best nonlinear model for describing complete lactation of Akkaraman breed and German Blackheaded Mutton x Akkaraman B_1 Crossbreed Sheep was found to be Cubic model, which might provide useful clues not only for breeding schedules but also for developing appropriate management.

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