GENETIC AND PHENOTYPIC PARAMETERS OF TOTAL MILK YIELD AND LACTATION CURVE PARAMETERS ESTIMATED BY THE GAMMA FUNCTION IN EGYPTIAN BUFFALOES

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INTRODUCTION

Genetic selection for parameters of lactation curve can change the shape of lactation in an economically desirable direction. Genetic variation exists for parameters of lactation curve indicating that the shape of lactation can be modified genetically. The objectives were to

1. estimate lactation curve parameters of Egyptian buffalo using the linear and the nonlinear forms of the incomplete gamma function.
2. estimate genetic and permanent environment parameters of lactation curve parameters and total milk yield.

MATERIALS AND METHODS

Data on 2617 weekly milk yield records representing the first ten lactations of 1080 Egyptian buffaloes from 1989 to 1999 were collected from a herd belonging to the Animal Production Research Institute (APRI), the Ministry of Agriculture, Egypt. Numbers of records in the ten parities were 338, 354, 318, 305, 300, 244, 230, 175, 136, 217, respectively. Animals were naturally mated and milking was twice daily by hand. Weekly milk yield was the sum of the recorded daily milk production throughout the week. Maximum number of weeks in milk was 53.

Lactation curve was described by the linear and the nonlinear forms of the incomplete gamma function, as follows:

$$Y_n = a n^b e^{-cn}$$

Where

Y_n is the average milk yield in time period n,

a is the level of initial yield of the buffalo cow,

b is the rate of increase to peak,

c is the rate of decline after peak

n is the time period, which is a week in this study

Taking the natural logarithm, the above formula becomes

$$\ln(y_n) = \ln(a) + b \ln(n) - cn$$

The linear form was fitted by PROC GLM in SAS (2000), while the nonlinear form was fitted by the Newton method using PROC NLIN of SAS (2000). Lactation curve parameters were obtained for each individual buffalo within parity.

A multiple trait animal model analysis was conducted on total milk yield, initial yield (a), rate of increase to peak production (b) and rate of decline after peak (c), using the 5.1.2 version of VCE program. The model included year-month of calving, parity and age at calving nested within parity, as fixed effects and animal additive genetic and animal permanent environment as random effects.

RESULTS AND DISCUSSION

Means and standard deviations of lactation curve parameters estimated by the linear and the nonlinear forms of the incomplete gamma function are presented in Table (1). Mean of the initial milk yield (a) estimated by the linear form was lower than that estimated by the nonlinear form, while means of the rate of increase to peak production (b) and the rate of decrease after peak (c) estimated by the linear form were higher.

Table(1): Means ± standard deviations (SD) of the initial milk yield (a), the rate of increase to peak production (b) and the rate of decrease after peak (c) as estimated by the linear and the nonlinear form of the incomplete gamma function.

Trait	Linear	Nonlinear
a	3.55 ± 0.37*	38.80 ± 13.96
b	0.55 ± 0.44	0.43 ± 0.46
c	- 0.10 ± 0.12	- 0.08 ± 0.10

* The value is log(a) (a=34.81)

Heritability (h^2) estimates of total milk yield (TMY), a, b and c as well as genetic and phenotypic correlations among them are presented in Table (2). Heritability estimates of TMY and the rate of decline after peak (c) of both forms were equal, accounting for 0.31 and 0.54, respectively. Heritability estimates of the initial milk yield (a) and the rate of increase to peak production (b) of the linear form were slightly higher than those of the nonlinear form. Estimates of h^2 were relatively moderate, except that of the rate of decrease after peak (c), suggesting a good opportunity for modifying lactation curve by selection.

Strong genetic correlations were observed between b and c and between TMY and each of b and c. On the other hand, genetic correlation between TMY and the initial yield (a) was low, suggesting that improving the later trait would not have a great influence on improving milk yield. Phenotypic correlations among the studied traits were lower than the corresponding values of the genetic correlation.

Table(2): Heritability (on diagonal), genetic (above diagonal) and phenotypic (below diagonal) correlations of the total milk yield (TMY), initial milk yield (a), the rate of increase to peak production (b) and the rate of decrease after peak (c) as estimated by the linear and the nonlinear forms of the incomplete gamma function.

Trait	Linear				Nonlinear			
	TMY	a	b	c	TMY	a	b	c
TMY	**0.31**	0.05	-0.84	0.86	**0.31**	0.35	-0.82	0.84
a	0.05	**0.25**	0.18	-0.28	0.14	**0.20**	-0.21	-0.04
b	- 0.35	-0.52	**0.33**	0.97	-0.26	-0.48	**0.28**	0.97
c	- 0.27	-0.08	-0.88	**0.54**	-0.47	-0.13	0.84	**0.54**

Ratio of permanent environmental variance to the phenotypic variance (p^2) and the repeatability estimates ($t=h^2+p^2$) for the studied traits are presented in Table (3).

The p^2 estimates obtained for both forms were approximately equal. Estimate of p^2 of TMY was the highest, accounting for 0.12. In contrast, the values of p^2 of a, b and c were very low. The t estimates of TMY and c of both forms were equal, while those of a and b of the linear form were slightly higher. The estimate of repeatability of the rate of decrease after peak was the highest, followed by that of TMY.

Table(3): Ratio of permanent environmental variance (p2) to the phenotypic variance and repeatability (t) of the total milk yield (TMY), initial milk yield (a), the rate of increase to peak production (b) and the rate of decrease after peak (c) as estimated by the linear and the nonlinear forms of the incomplete gamma function.

Trait	Linear		Nonlinear	
	p^2	t	p^2	t
TMY	0.12	0.43	0.12	0.43
a	0.001	0.25	0.001	0.20
b	0.01	0.34	0.02	0.30
c	0.01	0.55	0.01	0.55

CONCLUSION

1. Shape of lactation curve can be modified by genetic selection.
2. Animals with higher rate of increase to peak production and lower rate of decrease after peak tend to have higher total milk yield.
3. Future work is needed to analyze lactation curves of different parities as different traits. Preliminary analysis has shown significantly different lactation curves for different parities, suggesting that each lactation should be considered as a different trait.