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GENETIC ANALYSIS OF SOME PRODUCTIVE AND REPRODUCTIVE TRAITS OF FIRST LACTATION OF FRIESIAN CATTLE RAISED IN EGYPT

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ABSTRACT

Data used in this investigation were collected from 4370 records relevant to 874 purebred Friesian cows which belong to Shobratana Animal Production Society, located in the north part of Delta region near Tanta city in Egypt. These cows were daughters of 43 sires. The records used covered the period from 1985 to 2003. The following six productive and reproductive traits of the first lactation were analyzed: Total Milk Yield (TMY, kg), dry period (DP, day), lactation length (LL, day), days open (DO, day), calving interval, (CI, month) and age at first calving (AFC, month).sire random effect and month and year fixed effect. Data were analyzed using Linear Mixed Model Least Squares and Maximum Likelihood (LSMLMW) computer program of Harvey (1990). The overall means of TMY, DP and LL were 5387 kg, 72.9 days and 327 days, respectively. The overall means of CI, DO and AFC were 13.4 month, 121 days and 27.8 month, respectively. Heritability estimates for TMY, DP, LL, CI, DO and AFC were 0.141±0.074, 0.109±0.069, 0.040±0.057, 0.104±0.068, 0.202±0.084 and 0.217±0.087 respectively. The ranges of breeding values of all sires in the pedigree for TMY, DP, LL, DO and CI were 685 kg, 18 day, 8.15 day, 48.2 day and 1.05 month, respectively. Spearman rank correlations and Pearson correlations among estimated breeding values of all sires in pedigree provided by the genetic analysis ranged between -0.712 to 0.907. The objectives of the present study were: 1) to estimate some genetic and non-genetic factors affecting productive and reproductive traits, 2) to estimate genetic and phenotypic parameters for these traits and 3) to estimate breeding values for sire Friesian cows in this farm. Rank correlations of animals between traits were the lowest for reproduction traits. It could be concluded that improving the environmental conditions will improve these traits.
Keywords: Friesian cows, Genetic parameters, Breeding value, BLUP, Egypt

INTRODUCTION

The success of selection for milk production has contributed to the domination of the Friesian breed around the world. In Egypt, dairy industry represents 35% of the total animal production sector. During the last two decades, considerable emphasis had been placed upon the importance of Friesian cattle in Egypt for milk production, accordingly the number of large Friesian herds had increased either in the governmental or commercial farms through importation from Europe and USA (Shalaby *et al.*, 2001). Main reasons of low productivity of farm animals are; non-descript breed, poor management, lack of nutrition, lack of resources, low inputs; inadequate artificial insemination service and diseases. These causes lead to low average milk production, late age at first calving, delayed conception, impaired fertility, long calving intervals (Khan *et al.*, 2008). Low reproductive efficiency due either to delayed first service, missed estrus, or multiple services per conception continues to be a major problem in dairy herds. Insufficient reproductive performance results in excessively late age at first calving and long lactations. Both are costly to the dairy producers because of the veterinarian breeding expense, high reproductive replacement costs and fewer calves being born (Oudah *et al.*, 2001). The objectives of the present study were: 1) to estimate some genetic and non-genetic factors affecting productive and reproductive traits, 2) to estimate genetic and phenotypic parameters for these traits and 3) to estimate breeding values for sire Friesian cows in this farm.

MATERIAL AND METHODS

Data: Data used in this investigation were collected from 4370 records relevant to 874 purebred Friesian cows which belong to Shobratana Animal Production Society, located in the North Part of Delta region near Tanta city in Egypt. These cows were daughters of 43 sires. The records used covered the period from 1985 to 2003. The following six productive and reproductive traits of first lactation were analyzed: total milk yield (TMY, kg), dry period (DP, day), lactation length (LL,day), days open, defined as the interval from calving to conception, (i.e. the number of days between parturition and the insemination that resulted in a pregnancy) (DO, day), first calving interval, defined as the number of days occurring between first calving and 2nd calving (CI, day) and age at first calving, defined as number of months between date of birth and date of the first parturition of a cow (AFC, month).

Management: Animals were housed free in shaded open yards covered with 3.5-4 meters high roofs, grouped according to their average daily milk yield and were fed *adlibitum* on berseem (*Trifolium alexandrinum*) and rice straw in addition concentrates feed mixture from December to April (green season) and cows were fed daily on ration consisting of cotton seed cakes, barley wheat and rice bran,(not less than 18% crude protein from May to November (dry season). Mineral mixture bricks were offered *adlibtium* as lick salt in front animals, and on balanced ration of a concentrates according to their production and weight. Rice straw was offered *adlibitum* and sometimes limited amount clover hay when available. Water was also available freely. In general, cows were artificially inseminated during the first two heats which occurred after 60 days postpartum using imported frozen semen from USA and Canada. Heifers were artificially inseminated for the first time in the first two heats once they attained 350 kg of live body weight or 18-22 months of age. Pregnancy diagnoses were carried out routinely at 60 days after service by rectal palpation. If conception did not occur or the cows were seen in estrus, the cows were inseminated again. The cows were machine milked three times a day at 04.00, 12.00 and 19.00h. The calves born were artificially suckled from birth to weaning excluding colostrums' period.

Statistical analysis: Data were analyzed using Linear Mixed Model Least Squares and Maximum Likelihood (LSMLMW) computer program of Harvey (1990). Three models of statistical analysis were used for studying factors affecting some productive traits, i.e. total milk yield (TMY, kg), dry period (DP, day), lactation length (LL ,day), two reproductive traits: i.e., days open (DO, day) and calving interval (CI, month) and age at first calving(AFC, month).

1) The following first mixed model was used to analyze the productive traits:

$$Y_{ilm} = \mu + S_i + M_l + Y_m + bL_1(x_1 - \bar{x}_1) + bQ_1(x_1 - \bar{x}_1)^2 + bL_2(x_2 - \bar{x}_2) + bQ_2(x_2 - \bar{x}_2)^2\, e_{ilm}$$

Where:

Y_{ilm} = the individual observation,

μ = the overall mean,

S_i = the random effect of the i^{th} sire, i = 1 to 43,

M_l = the fixed effect of the l^{th} month of calving; l = 1, 2, 3,……., and 12 (January, February, March….. and December),

Y_m = the fixed effect of the m^{th} year of calving, l = 1, 2,3, ….., 19 (from 1985 to 2003),

bL_1&bQ_1 = Partial linear and quadratic regression coefficients, respectively for productive traits on age at first calving (months).

bL_2&bQ_2 = partial linear and quadratic regression coefficients, respectively for productive traits on days open (days),

x_1 = age at first calving(AFC) of cow, $\bar{x}_1$ average AFC, month;

X_2 = days open (DO) of cow, $\bar{x}_2$ average DO (day); and

e_{ilm} = Residual term assumed to be random and distributed as a normal distribution with mean zero and variance σ^2e.

2) The following second mixed model was used to analyze the reproductive traits:

$$Y_{ilm} = \mu + S_i + M_l + Y_m + bL_l(x_1 - \bar{x}_1) + bQ_l(x_1 - \bar{x}_1)^2 + bL_2(x_2 - \bar{x}_2) + bQ_2(x_2 - \bar{x}_2)^2 + e_{ilm}$$

Where all definitions as mentioned above except for:

bL_2&bQ_2= partial linear and quadratic regression coefficients, respectively for reproductive traits on total milk yield (kg) and x_2 = TMY of cow and $\bar{x}_2$ is average TMY (kg).

3) The following third mixed model was used to analyze the age at first calving:

$$Y_{ilm} = \mu + S_i + M_l + Y_m + e_{ilm}$$

Where all definitions as mentioned above

Heritability estimates (h^2) were computed by the paternal half-sib method according to formula outlined by Harvey (1990).

$$h^2 = 4\sigma^2 s / (\sigma^2 s + \sigma^2 e)$$

Estimation of sire transmitting ability (ETA's): The transmitting abilities of sires with at least 10 daughters were examined, and consequently the total number of sires used in estimation of ETA's was only 43 sires. Sire-transmitting ability (ETA) for different traits was estimated by Best Linear Unbiased prediction (BLUP). Data of the first lactation records were used for estimating BLUP values; one set of cross-classified non interacting random effect (sire) is absorbed according to Harvey (1990) where BLUP estimates for random sire effects absorbed by maximum likelihood were obtained. Rank correlation coefficients among sire transmitting abilities (ETA's) for different traits were estimated using the Spearman formula (Snedecor and Cochron, 1956).

$$Y = Xf + Zs + Wb + e$$

Where:

Y = a vector of observations for each trait,

X = a known fixed design matrix,

f = an unknown vector of fixed effects representing the mean of farm, origin and month and year of calving,

Z = a known design matrix,

s = an un-observable vector of random sire effects,

W = a vector of covariate variables (independent variables), age at first calving and Days open or total milk yield,

b = a vector of partial regression coefficient of Y on w,

e = An un-observable random vector of error with mean and variance-covariance matrix I σ^2e.

Where:

K = $(4 h^2) / h^2$, for each trait was added to the diagonal of sire effects in the matrix; h^2 is the heritability estimate.

$$\begin{bmatrix} X'X & X'Z & X'W \\ Z'X & Z'Z+k & Z'W \\ W'X & W'Z & W'W \end{bmatrix} \begin{bmatrix} f \\ s \\ b \end{bmatrix} \quad \begin{bmatrix} X'Y \\ Z'Y \\ W'Y \end{bmatrix}$$

RESULTS AND DISCUSSION

Overall means, standard deviations (SD) and coefficients of variation (CV %) are shown in Table 1. The present overall mean of TMY was 5387 kg similar results were (5283 kg) found by Tag El-Dein (1997) working with another set of Friesian cows at the same farm and much higher than the published estimates on Friesian cattle in Egypt 2655 kg by Oudah and Zainab (2010), 3936 kg by El-Awady and Oudah (2011) and 2871 kg by Khattab and Sultan, 1990) and higher than those obtained by Khattab and Atil (1999) and Oudah *et al.* (2000) being 3709 and 3475 kg, respectively. And with 3710 kg that obtained by Tadesse *et al* (2010) for Friesian in Ethiopia, 5905 kg that found by Ajili *et al* (2007) in Tunis, 4489 kg that reported by Ahmed *et al*

(1997) in Libya. The present overall mean of DP (72.9 days) was shorter than that reported by Oudah *et al.* (2001) on Friesian cattle in Egypt (79.3 days). But it was longer than that obtained by Khattab and Atil (1999) being 65 days. The present overall mean of LL was 327 days. This length fell within the range reported by Skalicki and Latinovic (1990) who recorded almost similar results (344 days) for LL in Friesian cows in India. However a shorter mean (291.86 days) was stated by Sattar *et al* (2005). The overall means of DO and CI reported in the present study were 121 days and 13.4 month, respectively (Table 1). These values were lower than the estimates (141 and 422 days, respectively) reported by Shalaby *et al.* (2001) on a similar Friesian herd in Egypt. The overall mean of AFC was 27.8 months (Table 1). Higher than estimate (27.1 months) of AFC of Friesian cattle in commercial herds in Egypt was depicted by Sadek *et al.* (1994). In the present study, the coefficients of variations (CV %) ranged from 13.1 for AFC to 71.8% for DP. Such large coefficients of variation are indicative leaders for opportunities for improvement in these traits. The differences between our findings and other investigators may be related to genetic differences between breeds, climatic conditions, differences in statistical models, managerial practices and/or feeding systems.

Table (1): Overall mean, standard deviation (SD) and coefficients of variation (CV %) of Productive and Reproductive traits for first lactation of Friesian cow.

Productive trait:	Mean	SD	CV%
Total Milk Yield (TMY kg)	5387	2021	37.5
Dry Period (DP day)	72.9	52.4	71.9
Lactation Length (LL day)	327	67.8	20.7
Reproductive trait:			
Calving Interval (CL month)	13.4	2.96	22.1
Days Open (DO day)	121	71.2	58.8
Age at First Calving (AFC month)	27.8	3.64	13.1

Heritability and correlations: productive traits: Heritability estimates ± standard errors (SE), genetic correlations ± standard errors (SE) (above diagonal), environmental and phenotypic correlations for Productive and Reproductive traits for first lactation of Friesian cows are presented in Table 2. Heritability estimate for TMY reported in the present study (0.141± 0.074) was lower than that obtained in other countries by Swalve and Van Vleck (1987) working on Holstein Friesian cattle being 0.32. From the heritability estimates obtained in the present study for TMY, DP, and LL, it could be concluded that the low heritability estimates are enough to allow genetic improvement in milk production traits, which could be achieved through selection. Badawy and Oudah (1999) and Oudah *et al.* (2000) came to the same conclusion. Concerning the heritability estimate of DP obtained in the present study (0.109± 0.069), high result (0.02) was found also by Salem and Abdel Raouf (1999) working on Holstein Friesian cattle in Egypt. The present low heritability estimate of DP indicates that the major part of variation in this trait is due to the non-genetic factors and great improvement could be achieved in this trait by improving management systems. The present genetic correlation coefficients between TMY and DP was negative (-0.545) and between TMY and LL (1.522) was high and positive (Table 2). The higher and positive genetic correlation coefficient among TMY and LL indicates that selection for TMY will improve the other traits. Similar results were found by Tag El-Dein (1997) and Oudah *et al.* (2000). The present phenotypic correlation coefficient between TMY and DP was -0.02 and that between TMY and LL (0.160) was positive. These results are in the agreement, in most cases, with those reported by Khattab and Sultan (1990) and Tag El-Dein (1997) on Friesian cattle in Egypt. The environmental correlation coefficients among all traits were generally less than the values of genetic correlation coefficients (Table 2) which may be due to more contribution of additive genetic deviation.

Table (2): Heritability estimates ± standard errors (SE) (on diagonal), genetic correlations ± standard errors (SE) (above diagonal), environmental (between parentheses) and phenotypic correlations (below diagonal) for factors affecting Productive and Reproductive traits for first lactation of Friesian cow.

Productive traits:	TMY	DP	LL
TMY	**0.141± 0.074**	-0.545± 0.446 (0.053)	1.522 ± 0.983 (0.051)
DP	-0.021	**0.109 ± 0.069**	-1.370 ± 1.527 (-0.449)
LL	0.160	-0.505	**0.040 ± 0.057**
Reproductive traits:	**CI**	**DO**	**AFC**
CI	**0.104± 0.068**	1.046 ± 0.093 (0.775)	--------
DO	0.807	**0.202 ± 0.084**	----------
AFC	--------------	-----------	**0.217± 0.087**

Reproductive traits: Heritability estimates (±SE) based on paternal half-sibs for reproductive traits as well as genetic, phenotypic and environmental correlation coefficients between them are presented in Table 2. The lower heritability estimates of DO (0.202± 0.084), CI (0.104± 0.068) and AFC (0.217±0.o87) indicate that selection for these traits would not be effective in bringing about genetic improvement, therefore improving the environmental and managerial conditions should lead to considerable improvement in these traits. The present lower heritability estimates for both DO and CI were confirmed previously by many authors under Egyptian conditions such as Salem and Abdel-Raouf (1999). The present genetic and phenotypic correlation coefficients between DO and CI (1.046) and 0.807, respectively) were positive and highly significant (Table 2). Lower genetic and phenotypic correlation coefficients were found by Salem and Abdel-Raouf (1999) being 0.64 and 0.82, respectively. Genetic and phenotypic correlations among Productive and Reproductive traits for first lactation of Friesian cow were given in Table 3. The genetic and phenotypic correlation coefficients between CI and TMY were-0.193 and 0.207, respectively. And those between DO and DP (0.583 and 0.425 respectively) were positive and also the genetic and phenotypic between AFC and LL were 1.47 and -0.004, respectively.

Table (3): Genetic correlations ± standard errors (SE) and phenotypic correlations (between parentheses) among productive and reproductive traits for first lactation of Friesian cow.

Traits	TMY	DP	LL
CI	-0.193±0.499 (0.207)	0.720±0.288 (0.564)	0.566±0.408 (0.747)
DO	-0.180±0.399 (0.221)	0.583±0.288 (0.425)	0.869±0.213 (0.737)
AFC	0.651±0.337 (0.098)	-0.788±0.338 (-0.033)	1.47±0.668 (-0.004)

Estimated breeding values:

Minimum and maximum for breeding values for different studied traits are presented in Table 4. The ranges of all animals in the pedigree for TMY, DP, LL, DO and CI were 685 kg, 18 day, 8.15 day, 48.2 day and 1.05, month respectively. The present results indicated that there was wide range of breeding values for all studied traits. The results similar by Oudah and Zainab (2010) for TMY and LL were 559 kg and 9.85 day respectively.

Table (4): Minimum and maximum for breeding values for different studied traits.

Trait	Min	Max	Range
Productive trait:			
TMY (kg)	-299	386	685
DP (day)	-9.76	8.24	18.0
LL (day)	-3.35	4.80	8.15
Reproductive trait:			
DO (day)	-26.6	21.6	48.2
CI (month)	-0.56	0.48	1.05

Correlations between estimated breeding values:

Spearman rank correlations and Pearson correlations between EBVs for studied traits obtained for all animals in the pedigree are presented in Table 5. Correlations between estimated breeding values of all animals in pedigree (sires) provided by the genetic analysis ranged between - 0.712 to 0.907. Rank correlations of animals between traits were the lowest for reproduction traits. Oudah and Zainab (2010) and Shalaby (2005) obtained similar results.

Table (5): Spearman rank correlations (above diagonal) and Pearson correlations (below diagonal) among breeding values of different studied traits.

Trait	TMY	DP	LL	DO	CI
TMY		-0.258	0.451	-0.250	-0.211
DP	-0.274		-0.712	0.088	0.176
LL	0.452	-0.716		-0.231	-0.142
DO	-0.375	0.089	-0.204		0.907
CI	-0.351	0.202	-0.083	0.887	

CONCLUSION

The low heritability of some traits studied indicated that the major part of the variation in these traits was environmental and selection may not prove effective in bringing about genetic improvement in these traits. Therefore, better management can play a major role in improving these traits.

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تحليل وراثي لبعض الصفات الإنتاجية والتناسلية لموسم الحليب الأول للأبقار الفريزيان المرباة في مصر

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استخدمت في هذة الدراسة ٤٣٧٠ سجل لعدد ٨٧٤ بقرة فريزيان أبناء ٤٣ طلوقة خلال الفترة من ١٩٨٥ وحتى ٢٠٠٣ من قطيع تجارى تابع لجمعية الثروة الحيوانية بشبراتانا – طنطا – محافظة الغربية بهدف دراسة بعض الصفات الإنتاجية والتناسلية لموسم الحليب الأول لهذه الحيوانات وكانت الصفات المدروسة هي انتاج اللبن الكلى ، فترة الجفاف، طول موسم الحليب، طول مدة التلقيح، الفترة بين ولادتين والعمر عند أول ولادة والنموذج المستخدم في التحليل هو هارفى (١٩٩٠)

وكانت أهم النتائج المتحصل عليها هى:

- متوسط إنتاج اللبن الكلى للموسم الاول هو ٥٣٨٧ كجم. طول فترة الجفاف لهذه الأبقار هي ٧٢,٩ يوم. طول موسم الحليب لهذه الأبقار ٣٢٧ يوم. الفترة بين ولادتين هي ١٣,٤ شهر. طول فترة التلقيح ١٢١ يوم. العمر عند أول ولادة ٢٧,٨ شهر.
- قيم المكافئ الوراثى لإنتاج اللبن الكلى ،فترة الجفاف، طول موسم الحليب،الفترة بين ولادتين، فترة التلقيح والعمر عند أول ولادة هي ٠,١٤١±٠,٠٧٤ ، ٠,١٠٩±٠,٠٦٩، ٠,٠٤٠ ± ٠,٠٥٧، ٠,١٠٤ ± ٠,٠٦٨، ٠,٢٠٢± ٠,٠٨٤ و ٠,٢١٧± ٠,٠٨٧ على الترتيب.
- القيم التربوية للطلائق لصفات إنتاج اللبن الكلي ، فترة الجفاف، طول موسم الحليب، فترة التلقيح والفترة بين ولادتين هى ٦٨٥ كجم، ١٨ يوم، ٨,١٥ شهر، ٤٨,٢ يوم و١,٠٥ شهر على الترتيب.
- معامل إرتباط الرتب بين القيم التربوية لكل الطلائق تتراوح مابين0.712- الى ٠,٩٠٧
- ونستخلص من هذه الدراسة أن قيم المكافئ الوراثي منخفضة لمعظم الصفات المدروسة وبالتالى يجب أن تهتم المزرعة بالعوامل البيئية والرعاية اللازمة لهذه القطعان لزيادة الإنتاج بصفة عامة.

قام بتحكيم البحث

أ.د / محمد نجيب العريان	**كلية الزراعة – جامعة المنصورة**
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