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Genetic Study of Fertility Traits and Productive in a Local Born Friesian Cattle in Egypt

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Abstract

A total 1481 first lactation records of local born Friesian heifers were collected from Sakha Farm, Animal Production Research Institue, Ministry of Agriculture, during the period from 1980 to 1993. A linear mixed model was used to study the fixed effects of month and year of calving, age at first calving as a covariate and the random effect of sire on productive traits (i.e., 90 day milk yield (90dMY), 305 day milk yield (305dMY), total milk yield (TMY), lactation period (LP) and dry period (DP)). The effects of the same factors on reproductive traits (i.e., days open (DO) and calving interval (CI)) were also studied. Least squares means of 90 dMY, 305 dMY, TMY, LP, DP, DO and CI were 959 kg, 3252 kg, 3709 kg, 367 d, 65 d, 145d and 426d, respectively. A least squares analysis of variance showed significant effect of month of calving on 90 dMY, 305 dMY, TMY and LP ($p<0.05$ or $p<0.01$). Year of calving had a significant effect on all traits studied ($p<0.05$ or $p<0.01$). Including age at first calving (AFC) as a polynomial regression of the second degree in the model yielded significant ($p<0.05$ or $p<0.01$) partial linear regression coefficients of 90 dMY, 305dMY, TMY and DP on AFC while the quadratic term was significantly only for 305dMY. Sire of the heifers had a significant effect on all productive traits. Heritability estimates for 90dMY, 305dMY, TMY, LP, DP, DO and CI were 0.30 ± 0.08, 0.30 ± 0.08, 0.15 ± 0.06, 0.10 ± 0.06, 0.09 ± 0.06, 0.05 ± 0.06, 0.05 ± 0.06, respectively. In addition, genetic and phenotypic correlations between different traits studied are calculated and tabulated. Negative genetic correlations between each of DP, DO and CI and 90dMY, 305dMY and TMY concluded that selection against dry period and days open will increase milk yield. Therefore, a reduction of DP and DO are the desirable goal of dairymen.

Introduction

Milk yield and fertility traits are the principal factors affecting profitability of a dairy herd. Early postpartum breeding in dairy animals, high fertility, short dry period and early maturity are resulted in more calves and high milk yield per unit of time throughout the herdlife (Britt, 1975). The genetic importance of fertility in dairy cattle should be evaluated for its direct effect on cows reproductive performance and its association with milk yield. Olds *et al*. (1979), Janson (1980), Khattab *et al*. (1987), Kafidi *et al*. (1992), Bagnato and Oltenacu (1993) and El-Nady (1996) concluded that fertility traits have low heritabilities, generally between 0.01 and 0.10, indicating that little genetic improvement for reproductive performance can be expected.

Negative influence of level of milk production on fertility has been observed by numbers authors Everett *et al*. (1966), Olds *et al*. (1979), Janson (1980), Afifi *et al*. (1992), Kafidi *et al*. (1992) and Soliman and Hamed (1994). In addition, Hansen *et al*. (1983) found that selection for fertility is possible but it will generally be associated with a decline in production and concluded it was not economically feasible. On the other hand, Seykora and McDaniel (1983) concluded that selection for the improvement of reproductive performance could be economically justified. The objectives of this work are estimate nongenetic factors affecting productive and reproductive traits and estimated the phenotypic and genetic parameters for the same traits in a local born Friesian cattle in Egypt.

Materials and Methods

A total of 1481 first lactation records of local born Friesian cattle were used for the present study. Animals are a part of the herd of Sakha Farm Animal Production Research Institute, Ministry of Agriculture. Records were produced during the period 1980 to 1993, inclusive. Abnormal records affected by diseases or by disordes such as abortion were excluded. Productive traits studied are 90 day milk yield (90dMY), 305 day milk yield (305dMY), total milk yield (TMY), lactation period (LP) and dry period (DP). Reproductive traits are days open (DO) and calving interval (CI). The number of sires and the average of daughters per sire were 128 and 10.94, respectively. Genetic analysis included the sires which have at least 5 daughters. Artificial insemination (AI) was used at random.

Cows of that herd were kept under a regular system of feeding and management adopted by the Research Center, Ministry of Agriculture. Animals were grazing on Egyptian clover (*Trifolium alexandrinum*), berseern during December to May, during the rest of the year they were given pelleted concentrates and rice straw. Heifers were attempted for service for the first time when they reached 18 mo or 350 kg. Rectal palpation for pregnancy diagnosis was performed 60 days after the last service. Cows were machine milked. Records incuded number of days open, which was computed as the interval between parturition and the date of successful mating or by subtracting the mean of gestation period estimated from the present date as 285 days from the normal calving if the date of successful mating was not known. Length of dry period was computed by subtracting the date of last milking from the next calving of date. Records with missing drying off date were rejected. The period between two consecutive calving is known as calving interval, which includes the days open and the gestation length. For the least squares analysis of variance the following general linear model was used:

$$Y = Xb + Zs + Wb + e$$

where Y was a vector of observations for each of the traits, X was a known fixed design matrix, b was an unknown vector of fixed effects repesenting the mean, month and year of calving, Z was a known design matrix, s was a vector of covariate variable (age at first calving), b was a vector of partial regression coefficients of Y on W and e was an unobserved random vector of errors with mean zero and variance $1\sigma_e^2$.

Estimates of sire and remainder components of variance and covariance were computed according to Harvey (1987). Estimates of heritability (h^2) was calculated as four times the ratio of σ_s^2 (sire variance compontents) to the sum of $\sigma_s^2 + \sigma_e^2$ (remainder variance components). Standard errors of h^2 was calculated using an approximate formula described by Swiger *et al*. (1964). Genetic and phenotypic correlations were estimated as described by Harvey (1987).

Results and Discussion

Least squares means: Least squares means of different traits studied are presented in Table 1. Mean; reported here for 90 dMY (959 kg), 305dMY (3252 kg) and TMY (3709 kg) are higher than those reported for Friesian cattle raised in Egypt by (Khattab and Sultan, 1991; Afifi *et al*., 1992; Khalil *et al*., 1994; Abdel Glil, 1996). Khalil *et al*. (1994) found that mean of 90dMY, 305dMY, TMY (600 kg, 2384 kg and 2577 kg), respectively. While, the present means of 90dMY and 305dMY are lower than those reported by Hussen (1996) using a commercial herd of Holstein Friesian cattle in Egypt, being 1748 kg and 4938 kg, respectively. Also, Atay *et al*. (1995) and Kaya (1996) working on Holstein Friesian cattle in Turkey found that 305 dMY were 5480 kg and 5444 kg. In addition, Onenec (1997) working on Holstein Friesian cattle in Turkey found that 305dMY and TMY are 4789 kg and 4865 kg, respectively. For subtropical Arabian countries, Mansour (1992) with Holstein Friesian in the Kingdom of Saudi Arabia, reported higher means than those obtained here. Low milk yield of Friesian cows during the earlier period after importation may reflect the source of importation and may be due to the heat stress to which lactating cows were exposed since they need some time to adapt in subtropical and semi-arid areas.

In terms of lactation intervals, means of LP reported here (367 d) for Friesian falls with the range from 315 to 363 d for Egyptian reports (Ragab *et al*., 1973; Khattab and Sultan, 1991; Afifi *et al*., 1992; Khalil *et al*., 1994, El-Nady, 1996; Abdel Glil, 1996 and El-Awady, 1998). In Turkey, Atay *et al*. (1995) and Onenec (1997) reported that mean of LP are 339 and 287 d, respectively. Mean of DP (85 d) is shorter than those of Friesian cattle reported of the Egyptian studies (Afifi *et al*., 1992; Khalil *et al*., 1994; El- Nady, 1996).

Gill and Allaire (1976) found that maximum profit per day of herd life is expected for cows with 42 days dry. Khalil *et al*. (1994) found high coefficient of variability for DP (72.45%) they concluded that DP is mostly governed by environment and management of the herd which could bring down the DP in Friesian cattle in Egypt. The present means of DO and CI are 145 and 427 d (Table 1). The present means are similar to those obtained by El-Sedafy (1989) using another herd of Friesian cattle in Egypt. Khattab and Ashmawy (1988) suggested that days open length of 60-90 days was optimum length for attaining maximum production for Friesian cattle in Egypt.

The differences between our results and those of other workers could be due to differences in climatic and management conditions and/or genetic differences in herds.

Fixed effects: Morith of calving had a significant effect on productive traits (90 dMY, 305 dMY, TMY and LP, Table 2, $p<0.05$ or $p<0.01$), while, DP, DO and CI are not affected by month of calving. The present results are agree with those of Ragab *et al*. (1973), Ashmawy *et al*. (1986), Rege (1991), Abdel-Bary *et al*. (1992), Kafidi *et al*. (1992), Khattab (1992), Khalil *et al*. (1994), Gad (1995), El-Nady (1996), Malau-Aduli *et al*. (1996) and El-Awady (1998).

The highest frequency of calving were observed from December through May. It is noticed that the dairymen in Egypt concentrated their calving in winter months have the highest performance of milk trait, while those calving in summer months showed the lowest. The high 90dMY, 305dMY and TMY and longer LP in winter calvers could be attributed to the favourable climatic conditions for abundant growth and availability of good quality Egyptian clover (Berseem) during increasing stage of lactation. Also, heifers calving on winter and spring months had shortest DP, DO and CI, than heifers calving during summer and autumn. Poor results in breeding efficiency in summer are attributed to the high indicate of silent heat making detection of oestrus more difficult and to deficiency of Vit. A. Also, Rege (1991) working on Friesian cattle in Kenya, concluded that seasonal of variation in animal performance in the tropics is expected to be primarily a manifestation of variation in feed quality and quantity. El-Fouly *et al*. (1976) reported that preparing the animals to have the full chance for conception during the season of full ovarian activity (October-May) reduce DO considerably. While, Khalil *et al*. (1992) on Egyptian buffaloes found that summer calvers had the highest 90dMY and 305dMY. On the other hand, Eltawil *et al*. (1976) observed a consistent trend in season of calving effect on milk yield although not attaining statistical significance in most cases.

Year of calving had a significant effect on all traits studied (Table 2). The present results are agree with the findings on Friesian cattle raised in Egypt as reported by Ragab *et al*. (1973), Ashmawy and Mokter (1984), Afifi *et al*. (1992), Khattab (1992), Gad (1995), El-Nady (1996) and El-Awady (1998). The same findings are also reported on Friesian cattle raised in other countries by Sharma *et al*. (1987), Rege (1991), Kafidi *et al*. (1992), Atay *et al*. (1995), Lefton and Patina (1995), Kaya (1996), Malau-Aduli *et al*. (1996)

Table 1: Least squares means (LSM) and standard errors (S.E.) for factors affecting productive and reproductive traits in a local born Friesian cattle

Factors	N	Productive Traits										Reproductive Traits			
		90 dMY		305 dMY		TMY		LP		DP		DO		CI	
		LSM	SE	LSM	SE	LSM	SE	LSM	SE	LSM	SE	LSM	SE	LSM	SE
LSM	1481	959	13	3252	37	3709	49	367	4	65	1	145	2	427	5
Month of calving															
1	131	973	22	3291	67	3803	103	367	10	67	3	136	4	418	11
2	123	1016	22	3381	68	3963	106	385	10	63	3	141	4	444	10
3	149	988	22	3329	74	3791	114	382	11	65	3	139	4	440	11
4	138	959	22	3230	69	3684	106	363	10	61	3	142	4	423	10
5	129	965	23	3190	70	3676	108	368	10	65	3	143	4	429	11
6	104	948	22	3145	68	3498	105	344	10	66	3	147	4	409	10
7	131	936	22	3220	69	3628	106	364	10	64	3	144	4	427	10
8	124	865	24	3156	75	3527	116	348	11	67	3	145	4	412	11
9	96	958	23	3245	72	3620	111	354	10	65	3	141	4	427	11
10	100	943	22	3270	95	3727	102	375	10	72	3	144	4	440	11
11	114	865	24	3156	75	3527	116	348	11	67	3	145	4	412	11
12	142	988	21	3265	64	3905	98	387	9	64	3	138	4	410	11
Year of calving															
80	71	836	74	2522	231	2801	373	344	36	52	10	134	9	399	37
81	88	805	67	2655	208	3003	335	317	32	57	10	143	8	365	33
82	146	767	65	2506	202	2723	324	326	32	70	9	142	8	384	33
83	221	873	44	2802	37	3313	216	380	21	66	6	154	5	450	22
84	180	896	40	2871	124	3408	198	377	19	72	5	143	5	439	20
85	125	968	33	3113	103	3481	163	347	16	62	4	154	4	421	16
86	116	980	29	2956	89	3318	139	354	13	58	4	140	4	415	14
87	90	940	28	2981	87	3435	136	368	13	66	4	147	3	434	14
88	77	953	29	3369	91	4028	142	407	14	65	4	144	4	470	14
89	55	1015	30	3663	93	4224	147	382	14	66	4	141	4	441	15
90	42	1112	34	3861	107	4347	189	373	16	64	5	143	4	433	16
91	47	1197	38	4142	119	4745	189	399	18	69	5	138	5	453	19
92	104	1081	45	3975	139	4659	223	386	22	74	6	135	5	437	22
93	119	1030	45	4094	139	4444	223	372	22	71	6	145	5	433	22
Regression															
AFC(L)		2.26±0.5		4.33±1.5		5.17±2.5		-0.009±0.2		-0.22±0.07		0.02±0.06		0.17±0.2	
AFC(Q)		-0.01±0.02		-0.15±0.06		-0.16±0.09		0.006±0.008		-0.001±0.002		-0.003±0.002		-0.006±0.009	

Table 2: F-ratios for factors affecting productive and reproductive traits

S.O.V	d.f	Productive Traits					Reproductive Traits	
		90 dMY	305dMY	TMY	LP	DP	DO	CI
Sire	127	1.89**	1.88**	1.40**	1.20*	1.20*	0.39	0.32
Month of calving	11	3.10**	1.80*	2.01*	2.07*	1.15	1.25	1.51
Year of calving	13	6.05**	10.18**	5.79**	2.30**	3.31**	3.01**	2.05
Regression								
AFC (L)	1	20.92**	7.89**	4.30*	0.001	9.88**	0.110	0.001
AFC (Q)	1	0.45	6.84**	3.32	0.46	0.22	2.09	0.47
Remainder	1327	42275	407494	1067737	10141	806	638	1072

*p<0.05 **p<0.01

Table 3: Estimates of heritability, genetic correlations (below diagonal) phenotypic correlations (above diagonal) for productive and reproductive traits

Traits	90 dMY	305 dMY	TMY	LP	DP	DO	CI
90 dMY	0.30±0.08	0.57	0.40	0.07	-0.03	-0.02	0.02
305 dMY	0.72±0.11	0.30±0.06	0.80	0.36	-0.04	-0.05	0.33
TMY	0.51±0.19	0.90±-0.07	0.15 ±0.06	0.75	-0.03	-0.02	0.72
LP	0.07±0.28	0.32±0.25	0.69±0.18	0.10±0.06	-0.006	0.006	0.96
DP	-0.56±0.20	-0.59± 0.21	-0.77±0.21	-0.11±0.45	0.09±0.06	0.03	0.003
DO	-0.13±0.22	-0.55±0.21	-0.55±0.27	-0.25±0.37	0.44±0.35	0.05±0.06	0.25
CI	-0.13±0.28	-0.13±0.27	-0.53±0.24	0.94±0.04	-0.003±0.46	0.14±0.05	0.05±0.06

and Kaygisiz (1997). In addition, Metry *et al*. (1994) working on Egyptian buffaloes found that' year of calving had a significant effect on TMY, LP, DP, DO and CI. Also, Soliman and Hamed (1994) found significant effect of year of calving on productive and reproductive traits on Braunvieh cows, they concluded that the least squares means of year of calving shows that was an upward trend in all traits studied, the upward trend is probably due in part to genetic improvement and partly due to improved feeding and management.

The present results show that change in production and reproductive traits studied from year to year can be attributed to change in herd size, age of animals, improved management practiced introduced from year to another and phenotypic trend. Also, the present results Table 1, show that 90dMY, 305dMY and TMY increased from about 770 kg, 2500 kg and 2800 kg in the early eighty to nearly 870 kg, 2800 kg and 3300 kg in the ninety, while, LP, DP, DO and CI in most cases decreases, this could be due to positive phenotypic trend in this herd. Abdel Glil (1996) working in the same herd, concluded that phenotypic trends for 305dMY, TMY and LP were 30 kg, 36 kg and -2.30 d, respectively. In recent years dairy cattle breeders in Egypt succeeded to improve the reproductive performance of their cows by reducing the CI through fixing lactation period and decreasing DP.

Estimates of partial linear regression coefficients of 90dMY, 305dMY, TMY and DP were significant, being 2.26 ± 0.50 kg/mo, 4.33 ± 1.54 kg Imo, 5.17 ± 2.50 kg/mo and 0.22 ± 0.02 d/mo, respectively (Tables 1 and 2), while, the quadratic terms were not significant on all traits, except for 305dMY (-0.145 ± 0.06 kg/mo). The curvilinear relationship of 305dMY on AFC are reported by Sallam *et al*. (1990), Khattab and Sultan (1991) and Abdel Glil (1996) using another sets of Friesian cattle in Egypt. Also, Ashmawy and Mokter (1984) and Afifi *et al*. (1992) working on British Friesian and Holstein Friesian cattle, respectively. While, Ashmawy *et al*. (1986) found that the linear regression coefficients of 305 day milk on AFC was positive and significant (18.82 kg/mo). The youngest first calves (26 mo) produced the lowest yield while, the oldest ones (42 mo) produced the highest yield .It is not justified to bring heifers into calving at an unduly old age although their first milk yield will increase because this results in decreasing the longevity and increasing the rearing the heifers. Also, Soliman and Hamed (1994) found that cows freshening at 40 month or more had the highest yield traits, while, the lowest productions was recorded for cows calved at 24 month of age.

The prediction curve based on the second degree polynomial regression of 305dMY with increasing in AFC. The present results indicate that increase in 305dMY with increase of AFC up to 40 mo and then decline. Therefore, a reduction in AFC is desirable for dairy breeders to prolong the length of herdlife and to economize the cost of heifers. Also, Ali *et al*. (1999) working on Nili Ravi Buffaloes, found that reduction in AFC will help to improve lifetime milk yield, longevity and reproductive ability as a correlated response. On the other hand, Schaefer and Henderson (1972), Basu and Ghai (1980), Sharma *et al*. (1987) and Abdel Glil (1996) found no significant effect of AFC on DO and CI.

F-ratios presented in Table 2 indicate that year of calving and AFC are considered the major factors affecting 90dMY, 305dMY, TMY, LP and DP. Afifi *et al*. (1992) came to the same conclusion using another data set from commercial Friesian herds. This leads to conclude that adjusting of lactation records for year of calving and AFC are very necessary for sire, evaluation.

Random effect: Sire of the heifers had a significant effect on productive traits ($p < 0.05$ or $p < 0.01$). These results are in agreement with those reported in the literature (Berger *et al*., 1981; Hansen *et al*., 1983; Sallam *et al*., 1990; Khattab and Sultan, 1991; Rege, 1991; Afifi *et al*., 1992; Kafidi *et al*., 1992; Metry *et al*, 1994; Gad, 1995; El-Nady, 1996; Abdel Glil, 1996; El-Awady, 1998). In practice, the present and reviewed studies concluded that the possibility of genetic improvement of milk through selection.

Genetic and phenotypic parameters Heritability estimates: Estimates of heritability (h^2) for different traits studied are presented in Table 3. Estimates of h^2 for. 90dMY, 305dMY and TMY are 0.30 ± 0.08, 0.30 ± 0.08 and 0.15 ± 0.06, respectively. Similary, Afifi *et al*. (1992) reported a corresponding estimate of 0.30 and 0.30 for 305dMY and TMY, respectively using another set of Friesian cattle in Egypt. Also, Ragab *et al*. (1973), Swalve and van Vleck (1987) and El-Nady (1996) reported that h^2 for 305dMY are 0.33, 0.33 and 0.36, respectively. In Turkey, Kaya (1996) working on four herds of Holstein cattle, found that h^2 for initial milk yield, 100 day milk yield and 305 day milk yield were 0.19, 0.24 and 0.19 for Tahirova herd, 0.32, 0.35 and 0.31 for Dalaman herd, 0.25, 0.23 and 0.26 for Turkgeldi herd and 0.11, 0.13 and 0.17 for Sarmisakli herd. According to moderate h^2 for milk traits it can be concluded that the genetic improvement in milk production can be achived through selection programme.

The estimate of h^2 for LP was 0.10 ± 0.06. The present estimate in agreement with those of Ragab *et al*. (1973), Afifi *et al*. (1992), El-Nady (1996) which ranged from 0.05 to 0.15. The present results indicate that the major part of variation in this character is due to nongenetic factors and great improvement in LP could be possible by imroving feeding and management systems. For DP, h^2 estimates was 0.09 ± 0.06, Kornel and Patro (1988) with Surti buffaloes, found that DP had negative h^2 estimate in four lactations meaning that the estimation is zero improving in management would be needed to decrease this trait. Basu and Gliai (1980) found that differences in DP between sire were not significant. El-Nady (1996) found that h^2 for DP was 0.02. Also, Metry *et al*., (1994) found that h^2 for DP was zero.

Heritability estimated for DO and CI are 0.05 ± 0.06 (Table 3). The low h^2 estimates for reproductive traits indicate that a major part of variation in these characters were environmental and selection would be not effective in bringing about genetic improvement. Better management can therefore play an important role in improving such trait. Therefore, improving the managerial technique should lead to a considerable in the length of reproductive traits. The present results are within the range obtained by Smith and Legates (1962), Everett *et al*. (1966) (0.07), Schaefer and Henderson (1972) (0.02-9.03), Khattab *et al*. (1987) (0.06), Afifi *et al*. (1992) (0.08), Bagnato and Oltenacu (1993) (0.03), Metry *et al*. (1994) (0.00) and El-Nady (1996) (0.01). Schaefer and Henderson (1972) reported that effect of days open on milk yield was almost all environmental. Khattab and Ashmawy (1988) concluded that selection for improved fertility defined as DO had little to offer to breeders. Low h^2 estimates of DO which is essentially zero, adjusted if lactation records for days open would not involve genetic influence on yield and or on sire and cow evaluation.

Correlations: Genetic correlations (r_9) and phenotypic correlations (r_p) between different traits studied are given in Table 3. Genetic correlations between 90dMY and each of 305dMY, TMY and LP also, between 305dMY and each of TMY and LP are positive and significant. The present results indicate that the initial milk yield could be used as indicators to early selection progress. Also, the genes associated with long lactation period are correlated with genes favourable for milk yield and selection against short LP is also expected against low production. The present results are in agreement with similar work on Friesian cows in Egypt (Ragab *et al*., 1973; Khattab *et al*., 1987; Hussen, 1996; Abdel Glil, 1996). Negative genetic correlations between productive traits (i.e., 90dMY, 305dMY and LP) and DP and all reproductive traits (DO and CI), except LP with CI, indicate that selection for short DP, DO and CI will lead to increase milk production. The present results are agreement with Schaefer and Henderson (1972), Afifi *et al*. (1992), Khattab *et al*. (1987) and Rege *et al*. (1991), while, Kragelund *et al*. (1979) found a high genetic correlations (0.62 to 0.72) between days open and milk yield in three analysis (based on a minimum of 2, 50 and 50 cows per sire) suggested a close relationship between breeding value of milk yield and days open. Genetic correlations between DP and each of DO and CI are positive and being 0.44 and 0.14, respectively.

Basu and Gahi (1980) reported that DP was positively correlated with CI and DO. Kragelund *et al*. (1979) and Afifi *et al*. (1992) reported positive r_g between DO and CI. The present results indicate that DO serves the same purpose as CI for evaluation of the reproductive performance of dairy breeders. Most estimates of r_p are similar to the corresponding estimates of r_g in the same direction, High positive r_p between 90dMY, 305dMY, TMY and LP indicate that 90dMY can be used for evaluating the milk producing ability in cows. Negative r_p between milk traits and DP and DO indicate that cows with shorter DP and DO with shorter LP will produce more milk during the first lactations. Finally, it is concluded from the present study that short dry period and days open will increase milk production, also, low h^2 estimates for reproductive traits indicate that little improvement for reproductive traits for Friesian cattle in Egypt can be expected.

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