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Genetic evaluation for productive and reproductive traits in Holstein Friesian cows under subtropical condition

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ABSTRACT

Lactation records (1,017) of Holstein cows, kept in private dairy farm in Egypt, from 2008 to 2015 were used for the study. The objectives were to estimate the effect of some factors on performance and estimate some genetic parameters. Traits studied were 305 day milk yield (305-dMY), lactation period (LP), peak milk yield (PY), number of services per conception (NSC), days open (DO) and calving interval (CI). Data were analyzed using Multi Traits Animal Model. Least squares means were 4436 kg, 215 d and 37 kg for 305-dMY, LP and PY, respectively, and 3.45, 182 d, and 452 d for NSC, DO and CI, respectively. Season and year of calving and parity had significant effects on all traits, except that of year of calving on PY and parity on NSC. Sire had significant effect only on 305-dMY and PY. Estimates of heritability for 305-dMY, LP, PY, NSC, DO and CI were 0.20, 0.07, 0.19, 0.07, 0.03 and 0.07, respectively. Phenotypic correlations among productive or reproductive traits were positive and between productive and reproductive traits were likewise positive. Genetic correlations among productive or reproductive traits ranged from 0.75 to 0.80 and 0.22 to 0.45, respectively.

Keywords: Genetic evaluation, Holstein cows, Productive, Reproductive

Milk yield characteristics and fertility performance of dairy cows are principal factors to affect the profitability of a dairy enterprise. Early maturity, high fertility and rapid postpartum conception bring about extra calves and, consequently, more milk yield per unit of time throughout the herd life of a dairy cow (Khattab and Atil 1999). The genetic influence on fertility of dairy cows should be evaluated before detection of the direct effect of reproductive performance on cow's milk yield and its association with fertility. Kafidi *et al.* (1992), El-Nady (1996), Khattab and Atil (1999) and Mariam *et al*. (2013) reported that fertility traits have low heritabilities ranging between 0.01 and 0.04 and concluded that little genetic improvement per unit of time can be achieved for reproductive performance traits. Moreover, the genetic correlation between milk yield and reproductive traits were negative. The objectives of this study were to: estimate the effect of non-genetic factors on some productive and reproductive traits and estimate heritabilities, phenotypic and genetic correlations for the same groups of traits in a commercial herd of Holstein Friesian cows in Egypt.

MATERIALS AND METHODS

Data of the present study were obtained from the history sheets of Holstein Friesian cows kept in Negim Private Farm, located in Garbyia Governorate in the middle of Delta region of northern Egypt and comprised 1,017 records on cows completed one or more normal lactations and calving between 2008 to 2015. Cows were kept loose under semi-open sheds all the year round and were fed on concentrate mixture, rice straw and were allowed to graze on berseem (*Trifolium alexandrinum*) when available. The concentrate mixture consisted of 45% cotton seed cake, 26% wheat bran, 17% yellow maize, 7% rice bran, 2% molasses, 1% sodium chloride and 2% calcium carbonate. Concentrates were offered according to cow body weight and milk production twice a day before milking. Heifers were first inseminated artificially at 18 months of age and for subsequent seasons were initially inseminated 60–70 days postpartum. Cows were machine milked twice a day and milk yield recorded daily. Late pregnant cows and those producing above 10 kg a day were given extra amount of concentrate ration. Complete or incomplete records were included only if the cow remained in the herd for full lactation of 305 day period. Lactations initiated after abortion or those interrupted by injury or sickness were excluded. The studied traits were 305 day milk yield (305-dMY), lactation period (LP), peak milk yield (PY), number of service per conception (NSC), days open (DO) and calving interval (CI).

Statistical analysis: Data were analyzed preliminarily using GLM procedure of the SAS Computational program (Statistical Analysis System 2004). The model included the

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Table 1. Unadjusted means, standard deviation (SD) and coefficient of variability (CV, %) for productive and reproductive traits in Holstein Friesian cows (no. = 1017)

Trait	Mean	SD	CV (%)
305 day milk yield (kg)	4436.00	2645.00	59.63
Lactation period (day)	215.00	131.00	60.93
Peak yield (kg)	37.00	9.00	24.32
No. of service/ conception	3.45	2.63	76.23
Days open (day)	182.00	124.00	68.13
Calving interval (day)	452.00	124.00	27.43

fixed effects of season and year of calving and parity and the random effects of sires and errors. Then the Multi Traits Animal Model (MTAM, Boldman *et al.* 1995) was utilized. The model included the fixed effects of month and year of calving and parity and the random effects of cows, permanent environment and residual.

RESULTS AND DISCUSSION

Unadjusted means, standard deviation and coefficient of variability for productive and reproductive traits are presented in Table 1. Means of 305-dMY and LP were lower than those reported by El-Arian *et al.* (2003) and Rashad (2013) who obtained ranges of 5021-5498 kg for 305-dMY and 286–390 d for LP when scrutinized data of other commercial herds of Holstein Friesian in Egypt. Mean of peak yield, however, was higher than those reported by El – Arian and Shalaby (2001) and El-Shalmani (2011) on other dairy herds of Friesian cows in Egypt, being 19.7 and 20 kg, respectively. Means of NSC, DO and CI for our study being 3.45, 182 and 452 d, respectively were lower than those reported by Rashad (2013) on another similar herd of Holstein Friesian cows in Egypt which were 185 and 469 d, respectively. However, the present NSC (3.45) was higher than that found by El-Nady (1996) which was 2.80 in another commercial herd of Holstein Friesian in Egypt. The large CVs for 305-dMY, LP, NSC and DO, reflect high variation between cows for such important traits of concern. Herd differences for these traits could be attributed to differences in climatic and management conditions and to the genetic background of cows in different commercial herds.

Non genetic factors: Least squares means and analysis of variance for the factors affecting productive and reproductive traits are presented in Tables 2 and 3. Year of calving had significant effects on 305-dMY, LP and PY and on NSC, DO and CI. These results are in agreement with those found on Friesian cows raised in different areas of Egypt (El-Nady 1996, Khattab and Atil 1999, El-Arian and Shalaby 2001, El-Arian *et al.* 2003, Noweir 2006, El-Shalmani 2011 and Rashad 2013). Similar results were also reported on Friesian cows in other countries (Kafidi *et al.* 1992, Bahreini *et al.* 2013, Mariam *et al.* 2013 and Goshu *et al.* 2014). Year to year variation in productive and reproductive traits may be attributed to changes in herd size, age of cows, diversed management practices from year to another and, consequently, phenotypic trends created by

Table 2. Least squares means ± standard errors for factors affecting productive traits in Holstein Friesian cows

Factor	LP (day)	305-dMY (kg)	PY (kg)
Year	**	**	**
2008	259.93±32.67[ab]	4032.60±247.10[c]	36.03±0.75[ab]
2009	219.45±29.14[ab]	4057.56±251.19[c]	37.79±0.72[a]
2010	252.09±22.91[ab]	4672.07±242.16[bc]	37.60±0.65[a]
2011	208.16±20.64[b]	4932.09±257.20[b]	37.01±0.69[ab]
2012	253.08±16.00[ab]	4821.59±252.75[b]	35.57±0.72[b]
2013	270.56±12.90[a]	4748.26±227.01[b]	35.18±0.70[b]
2014	240.37±11.07[b]	6235.64±212.62[a]	38.00±0.67[a]
Season	*	**	**
Autumn	206.46±17.36[c]	3449.69±167.90[c]	36.97±0.52[b]
Spring	304.89±24.63[a]	5027.14±267.13[a]	34.95±0.82[c]
Summer	262.18±19.84[ab]	4168.65±223.66[b]	32.64±0.72[d]
Winter	225.90±17.09[bc]	4522.27±185.34[ab]	38.48±0.53[a]
Parity	NS	NS	**
1	250.82±16.16	3946.83±168.81	29.50±0.53[c]
2	239.53±18.14	4557.92±202.56	38.16±0.62[a]
3	224.09±21.30	4528.79±245.47	38.69±0.71[a]
4	275.08±24.81	4251.38±258.31	37.09±0.78[ab]
5	259.75±23.99	4174.75±282.24	35.36±0.87[b]
Sire	NS	**	**

*, Significant at P≤0.05; **, Significant at P≤0.01; ns, non-significant (P≥0.05). [a-d]Means with different letters in the same row within the same are significantly different. 305-dMY, 305 day milk yield; LP, lactation period; PY, peak milk yield.

Table 3. Least squares means ± standard error for factors affecting reproductive traits for Holstein Friesian cows

Factor	DO (day)	CI (day)	NSC
Year	**	**	**
2008	232.13±10.77[a]	502.13±10.77[a]	3.54±0.24[bc]
2009	189.59±10.48[b]	459.58±10.48[c]	3.34±0.23[c]
2010	203.71±9.81[b]	473.71±9.81[b]	4.05±0.22[ab]
2011	185.10±10.34[b]	455.10±10.34[bc]	3.72±0.23[bc]
2012	193.89±11.22[b]	463.89±11.22[bc]	3.66±0.25[bc]
2013	209.55±10.75[ab]	479.55±10.75[ab]	4.52±0.24[a]
2014	193.11±10.03[b]	463.11±10.03[c]	3.84±0.22[bc]
Season	**	**	**
Autumn	171.91±8.01[c]	441.91±8.01[c]	3.03±0.18[c]
Spring	293.89±13.29[a]	563.89±13.29[a]	5.08±0.30[a]
Summer	193.05±10.77[b]	463.05±10.77[b]	3.05±0.24[c]
Winter	215.07±8.60[b]	485.07±8.60[b]	3.64±0.19[b]
Parity	*	*	NS
1	223.35±8.30[a]	493.35±8.30[a]	3.64±0.19
2	212.36±9.71[ab]	482.36±9.71[ab]	3.69±0.22
3	196.03±11.00[b]	466.04±11.00[b]	3.25±0.25
4	237.26±12.08[a]	507.26±12.08[a]	4.16±0.27
5	223.40±12.74[ab]	493.39±12.74[a]	3.76±0.29
Sire	NS	NS	NS

*, Significant at P≤0.05; **, Significant at P≤0.01; NS, non-significant (P≥0.05). [a-c]Means with different letters in the same row within the same are significantly different. DO, days open; CI, calving interval, NSC, number of service per conception.

these factors. Also, season of calving had significant effects on productive and reproductive traits (P<0.01). This is in agreement with results of El-Nady (1996), Khattab and Atil (1999), El–Arian *et al.* (2003), Noweir (2006), El-Shalmani (2011), Bahreini *et al.* (2013), Mariam *et al.* (2013) and Rashad (2013). Winter and spring calvers showed higher 305-dMY, LP and PY than summer and autumn calvers, probably due to the higher availability of green fodder and to the accessibility of the good weather. The longer DO, CI and NSC obtained for cows calving during winter and spring seasons reflect lower fertility measures and may be associated with high milk production of these cows. The antagonistic relationship between milk production and fertility are well documented and form a technical problem in the management practices of dairy enterprises.

Parity had significant effects on all studied traits (P<0.05 or 0.01). The present results are in agreement with those obtained by El-Nady (1996), Khattab and Atil (1999), El-Arian and Shalaby (2001), El-Arian *et al.* (2003), Noweir (2006), El-Shalmani (2011) and Rashad (2013). All traits increased with the advancement of parity till third or fourth then decreased thereafter. This is in logical agreement with the increase in body weight associated with advancement of age and the development of the secretory tissue of the udder. At this age, cows become mature with fully developed body weight and size accompanied by an increase in the size and functions of digestive and circulatory systems, mammary gland, and other body organs. This along with the increase in feed intake and feed utilization increase the efficiency of milk synthesis and secretion.

Sire effect: Sire had significant effects on 305-dMY and PY (P<0.01), but had no significant effect on LP, DO, CI and NSC. These results indicated that genetic improvement of milk yield could be achieved through sire selection. Similar results were reported by El-Nady (1996), Khattab and Atil (1999), Noweir (2006) and Rashad (2013).

Genetic parameters: The heritability estimates of productive and reproductive traits and phenotypic and genetic correlations among them are shown in Table 4. The heritability estimate of 305-dMY was 0.20. This value was similar to that estimated by Kafidi *et al.* (1992), Mostafa (2001) and slightly smaller than that reported by Bahreini *et al.* (2013) and Goshu *et al.* (2014), but were lower than that reported by El-Arian *et al*. (2003). Heritability estimate for PY was 0.19, nearly similar to those found by Noweir (2006) and Mariam *et al*. (2013). The moderate estimates of heritability for 305-dMY and PY suggest that more efforts should be made to bring about an improvement in milk yield through phenotypic selection, also better managerial practices should not be ignored. Estimate of heritability for LP was very small approaching 0.07 and was similar to that reported by El-Arian *et al.* (2003) and slightly higher than that reported by Mariam *et al*. (2013). Heritability estimates for DO, CI and NSC were 0.03, 0.07 and 0.07, respectively. The present low estimates were similar to those reported by Kafidi *et al.* (1992), E-Nady (1996), Khattab and Atil (1999), Noweir (2006), El-Shalmani (2011), Mariam *et al.* (2013) and Rashad (2013) which ranged from 0.01 to 0.08. Low heritability estimates for LP, DO, CI and NSC indicated that these traits are affected mainly by environmental factors. Therefore, improvement of feeding, management, detection of heat and insemination at proper time with good quality semen would help in improving NSC, DO and CI. Khattab and Atil (1999) for another herd of Friesian cows in Egypt, found that heritability for DO and CI were 0.05 and concluded that a major part of variation in these traits were of environmental origin and recommended that selection for these traits would not be effective in bringing about significant genetic improvement. Alternatively, good management practices can play an effective role in improving these traits.

Table 4. Heritability estimates (on diagonal), genetic correlation (below diagonal) and phenotypic correlation above diagonal among productive and reproductive traits

Trait	305-dMY	LP	PY	NSC	DO	CI
305 d MY	0.20	0.91	0.90	0.50	0.51	0.51
LP	0.77	0.07	0.85	0.80	0.91	0.91
PY	0.80	0.75	0.19	0.01	0.04	0.05
NSC	0.10	0.25	0.24	0.03	0.22	0.54
DO	0.05	0.35	0.23	0.27	0.07	1.00
CI	0.07	0.39	0.35	0.22	0.45	0.07

305-dMY, 305 day milk yield; LP, lactation period; PY, peak milk yield; NSC, number of service per conception; DO, days open; CI, calving interval.

Genetic correlations among 305-dMY, LP and PY were high, positive and ranged from 0.75 to 0.80. These results indicated that PY can be used successfully for early prediction of selection progress. These results also suggested that genes associated with long lactation period might be associated with those favourable for milk yield and, therefore, selection for length of lactation is also expected to increase milk production. These results were comparable to those found by El-Nady (1996), Khattab and Atil (1999), Noweir (2006), El-Shalmani (2011), Mariam *et al*. (2013). Genetic correlation between reproductive traits and milk traits though positive were moderate and ranged from 0.07 to 0.39. The implications of those results on genetic improvement in milk production are unfavourable might decrease breeding efficiency. Similar antagonism has been described by many authors (Kafidi *et al.* 1992, El-Nady 1996, El-Shalmani 2011 and Mariam *et al.* 2013) but the causal factors have not been well defined yet. This antagonism seems to be more pronounced for primiparous and decreases thereafter with parity advancement. On the other hand, Khattab and Atil (1999) found negative genetic correlation between milk traits and reproductive traits.

Most estimates of phenotypic correlations were similar in value and direct to the corresponding estimates of genetic correlation. High positive phenotypic correlations between 305-dMY, LP and PY indicated that the three traits can be used alternatively for evaluating milk producing ability of cow because cows with higher milk yield have high peak yield and are characterized with longer lactation period. The specific positive phenotypic correlations between milk production traits and DO and CI may occur through a direct causative relation; the longer DO will result in longer CI and consequently will allow more days in milk for the cow to produce more milk.

The moderate heritabilities for 305 day milk yield and peak yield indicated the possibility of achieving genetic improvement for milk production through selection. Whereas low heritability estimates for lactation period, number of service per conception, days open and calving interval may indicate that little improvement for reproductive traits may be expected in this herd but improvement may occur by developing more efficient feeding system and managerial practices.

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