Genetic Aspects of Some First Lactation Traits of Holstein Cows in Egypt

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ABSTRACT

Data on first lactation records of 696 pure Holstein cows presenting 73 sires and 565 dams raised at El-yoser private farm, 51 km south east of Alexandria, between 1995-2005 were utilized to study the genetic aspects of first lactation total milk yield (TMY), 305-days milk yield (305-DMY), lactation period (LP), first service period (FSP) and days open (DO).

The least squares analysis with unequal subclass numbers indicated that the overall means of TMY, 305-DMY, LP, FSP and DO were 10341.8 kg, 8455.4 kg, 391.2 day 127.0 day and 181.4 day, respectively.

Genetic and phenotypic parameters and breeding values for studied traits were estimated by MTDFREML with multiple-traits animal models. Heritability estimates were 0.44, 0.42, 0.48, 0.28 and 0.54 for TMY, 305-DMY, LP, FSP and DO, respectively. The genetic correlations were positive ranging from 0.03 to 0.35 except that between TMY and DO was negative (-0.31). Correlations among all traits were highly significant except those between TMY and FSP (0.03) and between LP and DO (0.05) were not significant.

The breeding values for TMY, 305-DMY, LP, FSP and DO of cows ranged between -3474.0 and 4416.7and -2567.2 and 2332.0 kg, and between -59.1 and 109.7, -42.0 and 32.3 and -48.0 and 33.7 days, respectively. The corresponding values for dams were between –3582.2 and 5088.1 and -2964.8 and 2368.5 kg, and between -74.7 and 99.3, -19.5 and 18.5 and -27.4 and 16.0 days, respectively. The breeding values for sires were between - 4012.3 and 2824.1 and -3069.0 and 1536.5 kg, and between -80.7 and 80.3, -16.1 and 15.1 and -14.7 and 19.9 days for the respective traits. The genetic trends estimated by the regression of sires breeding values on time were negative and nonsignificant for all traits under investigation.

Selection with high emphasis on TMY likely will not affect reproductive efficiency since its genetic correlations with FSP and DO approached zero or were mildly negative. Also, the results indicate the need for designing an effective selection programme to improve performance traits of cows in this herd.

Key words: heritability, genetic correlation, breeding values, genetic trend, milk yield, days open, Holstein cows.

INTRODUCTION

The cows' population in Egypt is continuously increasing and was recently estimated to be about 4.53 million heads. They produce about 2.90 and 0.41 million metric tons of milk and meat, which form 50.53 % of the total milk production (5.74 million metric tons) and 47.83 % of the total meat production (0.85 million metric tons), respectively (FAO, 2010).

In the last three decades, many private Holstein or Friesian dairy farms were established in Egypt. They are commonly found in the desert fringes of the delta governorates. Such large commercial dairy farms usually have stocks with herd size ranging from 200 to 500 lactating cows and are managed by experienced staff (Galal, 2007).

Although milk yield is a major trait with high economic importance for a dairy enterprise, other traits such as lactation period, first service period, and days open directly affect the profitability of the dairy farm (Hammoud, 1997; Dematawewa and Berger, 1998 and Tozer and Heinrich, 2001). Estimation of the genetic parameters for such performance traits in dairy cows is necessary for the determination of an optimal breeding strategies (Ahmad *et al.* 2001; Javed *et al.* 2004; Rahman *et al.* 2007; Rehman *et al.* 2008; Pantelic *et al.* 2011 and Zink *et al.* 2012).

The objective of this research was to study the genetic aspects of first lactation total milk yield, 305-days milk yield, lactation period, service period and days open of Holstein cows raised in a commercial herd in Egypt.

MATERIALS AND METHODS

Source of data:

Data were first lactation records of pure Holstein cows which belong to El-yoser private farm, 51km Alexandria-Cairo desert road. Records were of 696 cows presenting 73 sires and 565 dams and covered a period from 1995 to 2005. The first lactation traits were total milk yield (TMY, kgs), 305-days milk yield (305-DMY, kgs) and lactation period (LP, days), first service period (FSP, days) and days open (DO, days).

Herd management:

Animals were housed free in shaded open yards, grouped according to average daily milk yield, and fed ad libitum on corn silage mixed with concentrate ration (TMR) all year round and supplemented with *Alfa alfa* if available. Feeding allowances were offered according to milk production and physiological status as recommended by NRC (1989). Water was freely available all times. Heifers were artificially inseminated for the first time when reaching 360 kgs of weight and pregnancy was detected by rectal palpation 60 days after service. The cows were machine milked thrice a day at 06.00h, 13.00h and 18.00h.

Statistical analysis:

Least squares of GLM procedure (SAS 2008) were utilized to test the significance of the fixed effects of season of calving (4 seasons), year of calving (11 years) and age at first calving as a covariate. The statistical model fitted was:

$\mathbf{Y_{ijk} = \mu + S_i + T_j + + \beta\ (Age) + e_{ijk}}$ where,

Y_{ijk}: either TMY, 305-DMY, LP, FSP or DO; μ: an underlying constant specific to each trait; S_i: the fixed effect of i^{th} season of calving; T_j: the fixed effect of j^{th} year of calving; β: the linear regression coefficient of each trait on age at first calving and e_{ijk}: random residual assumed to be independent normally distributed with mean zero and variance σ^2_e. The initial run showed significant effects ($P < 0.05$) for season and year of calving, but the linear regressions of the studied traits on age at first calving were not significant. Therefore, age at first calving was omitted and only fixed effects were included in the analytical model.

Heritability, genetic correlations and breeding values of studied traits were estimated with derivative-free restricted maximum likelihood (REML) procedures using the MTDFREML program of Boldman *et al.,* (1995). The assumed model was:

y = Xb + Zu + e where,

y: a vector of observations, b: a vector of fixed effects with an incidence matrix X, u: a vector of random animal effects with incidence matrix Z, and e: a vector of random residual effects with mean equals zero and variance σ^2_e.

The genetic trends for the studied traits were computed as the regression coefficients of sires breeding values on their year of birth.

RESULTS AND DISCUSSION

The overall means of first lactation TMY, 305-DMY, LP, FSP and DO were 10341.8, 8455.4 kg, 391.2, 127.0 and 181.4 days, respectively (Table 1).

Table 1: Means, standard deviations (SD) and coefficients of variation (CV%) for 305-DMY (kg), TMY (Kg), LP (day), FSP (day), DO (day).

Trait	Mean ± SD	CV %
TMY	10341.8 ± 2980.1	28.8
305-DMY	8455.4 ± 1535.1	18.2
LP	391.2 ± 115.9	29.6
FSP	127.0 ± 92.8	73.0
DO	181.4 ± 117.0	64.5
No. of records	696	

The means of TMY and 305-DMY were lower than those found by Abou-Bakr *et al.*(2006) being 13172 and 10847 kg, respectively and those reported by Salem *et al.* (2006) being 12054 kg and 9038 kg, respectively on similar herds of Holstein cattle in Egypt. The mean of LP was higher than the mean of 370 days obtained by Abou-Bakr *et al.* (2006), but was shorter than that obtained by Salem *et al.* (2006) being 407 days. The estimate of DO obtained in this study was shorter than that of 255 days found by Abou-Bakr *et al.* (2000), but was longer than that of 154 days obtained by Abou-Bakr *et al.* (2006).

Π-Genetic parameters:

Estimates of variance components and heritability (h²) for first lactation TMY, 305-DMY, LP, FSP and DO are in table (2) and genetic correlations among the same traits are presented in table (3).

A- Heritability (h²):

Heritability (h²) estimates of 0.44, 0.42, 0.48, 0.28 and 0.54 were obtained for first lactation TMY, 305-DMY, LP, FSP and DO, respectively. These estimates indicated considerably high genetic to environmental variance ratio for these traits and reflected differences in the cows' response to the existing environmental conditions. These estimates were also higher than those depicted by Khattab and Sultan (1990) who reported heritability estimates of 0.31, 0.43 and 0.08 for TMY, 305-DMY and LP. Abdel-Glil (1996) reported heritability estimates of 0.41, 0.41, 0.27 and 0.12 for TMY, 305-DMY, LP and DO. Hammoud (1997) found heritability estimates of 0.33, 0.38, 0.33 and 0.21 for TMY, 305-DMY, LP and DO. Rehman *et al.* (2008) obtained heritability estimates of 0.11, 0.11and 0.09 for first lactation TMY, 305-DMYand LP of Sahiwal cattle. Tekerli and Kocak (2009) found heritability estimates of 0.27 and 0.02 for first lactation TMY and LP of Holstein cows in Turkey. El-shalmani (2011) obtained heritability estimates of 0.37, 0.38 and 0.42 for first lactation TMY, LP and DO. Pantelic *et al.* (2011) depicted heritability estimates of 0.49, and 0.08 for first lactation TMY and LP of Simmental cows in Serbia. Shalaby *et al.* (2012) reported heritability estimates of 0.14, 0.04 and 0.20 for first lactation TMY, LP and DO of Friesian cows in Egypt. Heritability estimates of 0.20 and 0.03 for first lactation TMY and DO were reported by Zink *et al.* (2012) for Czech Holstein cows.

B- Genetic correlation:

Genetic correlations among studied traits are presented in table (3). All correlations were positive ranging from 0.03 to 0.35, except that between TMY & DO was negative (-0.31). All genetic correlations were highly significant except those between TMY and FSP (0.03) and LP and FSP (0.05) were not significant. Therefore, selection for TMY may induce genetic improvement in the other traits. Selection with emphasis on TMY only may likely increase reproductive efficiency since there is a desirable genetic covariance existing between TMY and DO (-0.31). Construction of a selection index incorporating these traits and making use of the genetic, residual, and phenotypic correlations may increase accuracy and precision of estimates. Khattab and Sultan (1990) obtained genetic correlation of 0.94, 0.68 and 0.44 between TMY and 305-DMY, between TMY and LP and between 305-DMY and LP, respectively. Abdel-Glil (1996) found high positive genetic correlations of 0.34 to 0.92 among TMY, 305DMY, LP and DO of Friesian cattle. Hammoud (1997) obtained extremely high positive genetic correlations of 0.93 to 0.98 among TMY, 305DMY, LP and DO of Friesian cattle. Also, El-shalmani (2011) depicted high positive genetic correlations of 0.23 to 0.98 among TMY, LP and DO of Friesian cattle. Zink *et al.* (2012) obtained genetic correlation of 0.39 between TMY and DO.

III- Breeding values:

Estimates of breeding values of cows, dams and sires for first lactation TMY, 305-DMY, LP, FSP and DO are found in table (4). The breeding values for TMY, 305-DMY, LP, FSP and DO of cows ranged between -3474.0 and 4416.7, -2567.2 and 2332.0 kg, -59.1 and 109.7, -42.0 and 32.3 and between -48.0 and 33.7 day, respectively. The corresponding values for dams were between –3582.2 and 5088.1, -2964.8 and 2368.5 kg, -74.7 and 99.3, -19.5 and 18.5 and between -27.4 and 16.0 day, respectively. The breeding values for sires were between - 4012.3 and 2824.1, -3069.0 and 1536.5 kg, -80.7 and 80.3, -16.1 and 15.1 and between -14.7 and 19.9 day, respectively. The ranges of breeding values for cows were higher than those for dams or sires for all traits. El-shalmani (2011) estimated breeding values of Friesian sires ranged between -806.2 and 776.4 kg, between -14.2 and 14.4 day and between -23.7 and 38.9 day for TMY, LP and DO, respectively. Shalaby *et al.* (2012) estimated breeding values of Friesian sires ranged between -299 and 386 kg, between -3.35 and 4.80 day and between -26.6 and 21.6 day for TMY, LP and DO, respectively.

The genetic trends estimated as the regression coefficients of estimated breeding values of sires on time were negative and nonsignificant for all studied traits (Table 5). This might be attributed to lack of sires' selection or to use of sires with variable genetic background from different sources. Abdel-Glil (1996) obtained regression coefficients of estimated breeding values of Holstein sires on time of -12.20 ± 8.4 kg/year, -4.5 ± 3.8 kg/year and 1.89 ± 0.94 day/year for TMY, 305-DMY and LP, respectively. Also, El-shalmani (2011) reported regression coefficients of estimated breeding values of Friesian sires on time of -7.030± 1.830 kg/year, 0.001 ± 0.041 day/year and -0.096 ± 0.078 day/year for TMY, LP and DO, respectively, with no apparent specific genetic trend which reflected the lack of genetic progress achieved overtime.

Table 2: Additive genetic (σ^2_A), environmental (σ^2_E) and phenotypic variances (σ^2_P), and heritability (h^2) for TMY (Kg),305- DMY (kg), LP (day), FSP (day) and DO (day).

Trait	σ^2_A	σ^2_E	σ^2_P	h^2
TMY	613939	790384	1404323	0.44
305-DMY	466296	636551	1102847	0.42
LP	2848.64	3084.58	5933.22	0.48
FSP	2192.63	5608.17	7800.70	0.28
DO	3075.04	2666.78	5741.82	0.54

Table 3: Genetic correlations among TMY (Kg), 305-DMY (kg), LP (day), FSP (day), and DO (day).

Trait	305-DMY	LP	FSP	DO
TMY	0.35**	0.31**	0.03	-0.31**
305-DMY		0.29**	0.28**	0.32**
LP			0.05	0.34**
FSP				0.09**

**: Highly significant (P< 0.01)

Table 4: Breeding values for TMY (Kg), 305-DMY (kg), LP (day), FSP (day) and DO (day).

Trait	Cow breeding values		Dam breeding values		Sire breeding values	
	Min. ± S.E	Max. ± SE	Min. ± S.E	Max. ± SE	Min. ± SE	Max. ± SE
TMY	-3474.0 ± 1.51	4416.7 ± 1.50	-3582.1 ± 1.44	5088.1 ± 1.49	-4012.3 ± 1.57	2824.1 ± 1.49
305-DMY	-2567.2 ± 1.18	2332.0 ± 1.22	-2964.8 ± 1.21	2368.5 ± 1.25	-3069.0 ± 1.31	1536.5 ± 1.26
LP	-59.1 ± 0.06	109.7 ± 0.06	-74.7 ± 0.06	99.2 ± 0.07	-80.7 ± 0.07	80.3 ± 0.06
FSP	-42.0 ± 0.08	32.3 ± 0.08	-19.5 ± 0.13	18.5 ± 0.08	-16.1 ± 0.07	15.1 ± 0.10
DO	-48.0 ± 0.07	33.7 ± 0.07	-27. 4 ± 0.15	16.0 ± 0.07	-14.7 ± 0.09	19.9 ± 0.09

Table 5: Regression coefficients (b ± S.E)) of estimated breeding values of sires on their birth year for TMY (Kg), 305-DMY (kg), LP (day), FSP (day) and DO (day).

Trait	b ± S.E
TMY	-50.607 ± 43.918
305-DMY	-50.385 ± 29.846
LP	-0.825 ± 0.746
FSP	-0.254 ± 0.237
DO	-0.142 ± 0.301

CONCLUSIONS

The present heritability estimates for TMY, 305-DMY, LP, FSP, and DO emphasized the possibility of realizing a considerable rate of genetic improvement in the traits under investigation. The achieved genetic improvement would occur through selection for high TMY only due to the positive favourable correlated responses with all other studied traits. Such favourable relationships among the traits of economic value should increase the efficiency for such commercial dairy enterprise. The low negative genetic trends in sires for all studied traits were expected due to the absence of a long term plan for sire selection, and to the use of sires from different sources usually with variable genetic background. Long term selection programme to improve milk production and fertility of cows would be beneficial in this commercial herd and can be achieved through planned mating with semen of sires which possess high ETA for milk production obtained from trustable genetic source.

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الملخص العربى

السمات الوراثية لبعض صفات موسم الحليب الأول لأبقار الهولشتين في مصر

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أجري هذا البحث على بيانات قطيع أبقارالهولشتين بمزرعة اليسر الخاصة الموجوده بالكيلو ٥١ طريق إسكندرية- القاهرة الصحراوي. وقد شمل البحث بيانات سجلات موسم الحليب الأول لعدد ٦٩٦ بقرة نسل ٧٣ طلوقة و٥٦٥ أم خلال الفترة من ١٩٩٥ وحتى ٢٠٠٥. واستهدف البحث دراسة السمات الوراثية لبعض صفات موسم الحليب الأول لأبقار الهولشتين في هذا القطيع التجاري.

تم تحليل البيانات إحصائياً بطريقة الحد الأدنى للمربعات، وأوضحت النتائج أن المتوسط العام بلغ ١٠٣٤١.٨ كجم لإنتاج اللبن الكلي، ٨٤٥٥.٤ كجم لإنتاج اللبن في ٣٠٥ يوم، ٣٩٢.٧ يوم لطول موسم الحليب، ١٢٧.٠ يوم لفترة التلقيح الأولي و١٨١.٤يوم لفترة الأيام المفتوحة.

تم استخدام برنامجMTDFREML لتقدير المعايير الوراثية والقيم التربوية للصفات موضع البحث. كانت تقديرات المكافئ الوراثي لصفة إنتاج اللبن الكلي ٠.٤٤، لإنتاج اللبن في ٣٠٥ يوم ٠.٤٢، لطول موسم الحليب ٠.٤٨، لفترة التلقيح الأولي ٠.٢٨ و لفترة الأيام المفتوحة ٠.٥٤.

وكانت تقديرات الارتباط الوراثي موجبة وتراوحت بين ٠.٠٣ إلي ٠.٣٥ بين الصفات موضع الدراسة فيما عدا تلك التي بين إنتاج اللبن الكلي وفترة الأيام المفتوحة كانت سالبة -٠.٣١. وكانت كل تقديرات الارتباط الوراثي معنوية جداً فيما عدا تلك التي بين كل من إنتاج اللبن الكلي وطول موسم الحليب مع فترة التلقيح الأولي كانت غير معنوية. كما يتضح من التلازم الوراثي الموجب بين إنتاج اللبن الكلي وكل من إنتاج اللبن في ٣٠٥ يوم وطول موسم الحليب أن الانتخاب لصفة واحدة سيحدث استجابة غير مباشرة في باقي الصفات. بينما يتضح من التلازم

الوراثي بين كل من إنتاج اللبن الكلي مع كل من فترة التلقيح الأولي(٠.٠٣) وفترة الأيام المفتوحة(-٠.٣١) أن الأنتخاب لإنتاج اللبن الكلي سوف يؤدي إلي تحسين صفتي الخصوبة.

تراوحت تقديرات القيم التربوية للأبقار بين -٣٤٧٤.٠٠ و ٤٤١٦.٧ كجم، بين -٢٥٦٧.٢ و ٢٣٣٢.٠ كجم، بين -٥٩.١ و ١٠٩.٧ يوم، بين -٤٢.٠٠ و ٣٢.٣ بوم وبين -٤٨.٠٠ و ٣٣.٧ يوم بالنسبة لإنتاج اللبن الكلي، لإنتاج اللبن في ٣٠٥ يوم، لطول موسم الحليب، فترة التلقيح الأولي وفترة الأيام المفتوحة علي التوالي. أما تقديرات القيم التربوية للأمهات فتراوحت بين -٣٥٨٢.٢ و ٥٠٨٨.١ كجم، بين -٢٩٦٤.٨ و ٢٣٦٨.٥ كجم، بين -٧٤.٧ و ٩٩.٣ يوم، بين -١٩.٥ و ١٨.٥ يوم وبين -٢٧.٤ و١٦.٠ يوم بالنسبة للصفات السابقة علي التوالي. أما تقديرات القيم التربوية للطلائق فتراوحت بين -٤٠١٢.٣ و ٢٨٢٤.١ كجم، بين -٣٠٦٩.٠٠ و١٥٣٦.٥ كجم، بين -٨٠.٧ و ٨٠.٣ بوم، بين -١٦.١ و ١٥.١ يوم وبين -١٤.٧ و ١٩.٩ يوم بالنسبة للصفات السابقة علي التوالي. ويلاحظ أن هناك مدي واسع للقيم التربوية للأبقار بالنسبة لكل الصفات، بينما كان المدي متوسط للقيم التربوية للأمهات مقارنة بالأبقار وأما القيم التربوية للأباء فكان لها مدي منخفض مقارنة بالأبقار أوالأمهات.

وقد حسبت معاملات اعتماد القيم التربوية للأباء علي السنوات وكانت سالبة وغير معنوية لكل الصـفات. ولـم يوجد اتجاة وراثي محدد بالنسبة لكل الصفات وذلك لغياب الانتخاب الفعال للأباء.

بصفة عامة توضح نتائج هذا البحث أن الأنتخاب سوف يؤدي إلي تحسين الصفات موضـع البحـث كمـا أن الأنتخاب لإنتاج اللبن الكلي سيحدث استجابة غير مباشرة في باقي الصفات. كما توضح النتائج أن هنـاك ضـرورة حتمية لتصميم برنامج انتخاب فعال لتحسين الصفات الاقتصادية في هذا القطيع التجاري.