Estimation of Genetic Parameters and Trends for Milk Production in a Libyan Holstein Population under Arid Mediterranean Subtropical Conditions

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ABSTRACT: Heritabilities for the mean of the first 6 highest 3-wk test-days (M6HTD), 120-d milk yield (MY120), and 305-d milk yield (MY305), genetic correlations, and phenotypic correlations among these traits were estimated in a Libyan dairy population of 3,345 dairy cows that were progeny of 294 sires and 2,540 dams. Heritabilities were medium for M6HTD (0.20 ± 0.04) and MY120 (0.25 ± 0.04) and low for MY305 (0.14 ± 0.03). Genetic correlations were high and positive and phenotypic correlations were moderate and positive for all traits. Genetic trends for cows, sire, and dams were mostly negative and small or near zero suggesting that selection and breeding strategies were unsuccessful in this Libyan population during the period of the study.
Keywords:
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Introduction

The demand for animal products especially milk and dairy products increased dramatically in Libya in the last decade because of increases in population size, education and standard of living. The Libyan population is expected to double in less than three decades. The Ministry of Agriculture responded to increases in demand through several waves of importation of high yielding animals (primarily Holstein) from the European region through a poultry and cattle development program (PCDP). These importations started in early eighties and ended in the nineties after the start of the embargo. Large dairy projects were initiated through this national program. Despite the increase in the size of the dairy cattle population there is still a large gap between demand and supply of milk and milk products. This gap is increasing with the current rate of population growth and it is expected to increase further due to lack of proper management and genetic improvement programs. The development of genetic improvement programs in Libya requires the development and testing of genetic evaluation models that appropriately account for the structure of the dairy population and local hot and arid environmental conditions. The availability of a historical dairy dataset with information from government farms from 1982 to 2000 provided material for testing of genetic evaluation models and estimation of genetic parameters, an initial step in the development of a national dairy genetic evaluation system. This dataset also provided information on phenotypic and genetic changes that occurred during the time data were collected. Thus, the objectives of this research were: 1) to estimate variance and covariance components, heritabilities, genetic correlations, and phenotypic correlations for the mean of the first 6 highest 3-wk test-days (M6HTD), 120-d milk yield (MY120), and 305-d milk yield (MY305), and 2) to estimate genetic trends for cows, sires, and dams for these traits from 1982 to 2000 to assess the impact of dairy breeding practices and policies in Libya during this period.

Materials and Methods

Animals and data. The data used for this study were first-lactation milk yield records and pedigree information from 3,345 first lactation cows, daughters of 294 sires and 2,540 dams from two large government herds located in the mid-coastal area of Libya between Benghazi and Tripoli. Calvings occurred throughout the year from 1982 to 2000. The data was edited for erroneous and missing information. Records without sire, dam, birth date, calving date, and drying-off date information were excluded. Dairy traits considered in the study were: 1) mean of the first 6 highest 3-wk test-day records during the peak of production (M6HTD); 2) 120-d milk yield (MY120) = estimated total amount of milk produced during the first 120 d of lactation; and 3) 305-d milk yield (MY305) = estimated total amount of milk produced during 305 d of lactation. Two consecutive test-day milk samples were used to compute milk yield for each 3-wk test period, and then added to obtain the accumulated 120-d and 305-d accumulated milk yields. This procedure was similar to the simple aggregate method used by Sargent et al. (1968). The MY305 was calculated only for cows whose lactation length was equal or larger to 305 d. Total milk yield was considered to be MY305 for cows that dried off before 305 d. Cows that dried off due to mastitis or other health problems were projected to 305 d using within herd-age multiplicative factors estimated using least squares methods (Hermas, 1988; unpublished report) if their test-day records were high and they were far from drying off. Traits MY120 and H6TDP were chosen because these traits are expressed early in the lactation and they were expected to be highly associated with MY305. Further, production during the early part of the lactation largely determines cow profitability, is associated with persistency, and can be used for early selection to shorten generation interval.

Management and climate. The climate of the region where the two herds were located is Mediterranean. Seasons were summer (June, July, August), fall (September, October, November), winter (December, January, February), and spring (March, April, May). The first herd was located 20 km east of the capital Tripoli (altitude = 32.5º; longitude = 13.29º; elevation = 11 m above sea level). The average daily temperature ranges from 10 to 18 °C in winter and from 23 to 31 °C in summer. The average rainfall is 300 mm per year. The average annual relative humidity is 57.3% and ranges from 40 % in June to 70 % in December. The second herd was close to Benghazi, the second largest city in Libya (altitude = 32º; longitude = 21º; elevation = 300 m above sea level). The temperature ranges from 6 to 17 °C in winter and from 23 to 33 °C in summer. The rainfall is about 200 to 300 mm per year. The average relative humidity is 66.1% and ranges from 57% in May and June to 70% in January. Cows were kept semi tied in barns. Cows were also allowed to spend time in a yard. Cows were fed concentrate that had 17% CP, 70% TDN (DM basis) twice a day. Cows that produced 10 kg of milk were given 6 kg of concentrate and those that produced more were given 1kg per 2.5 kg of milk. Pregnant cows were offered 6 kg of concentrate. Dry non-pregnant cows were given 1 kg of concentrate. Roughage composed of mostly oats (*Avena sativa*) and barley (*Hordeum vulgare*) hay was given ad libitum four times a day at an approximate rate of 8 kg per milking cow. Green fodder and silage were given at libitum when available as a replacement for oats hay, mainly during spring and late winter. Green fodder consisted of alfalfa (*Medicago sativa*) and oats green chops. Minerals were given ad libibum as mineral blocks. The availability of concentrates and roughages was limited. Most feed ingredients were imported. Thus, the nutritional value and quantity of feeds offered fluctuated depending on the availability of feeds and funds. Cows were machine-milked in a milking parlor twice a day. The milk was processed in dairy processing facilities within each herd (mainly pasteurized milk or fermented milk for yogurts). Dairy products were sold in the nearby cities of Tripoli and Benghazi.

Genetic parameters and genetic trends. Restricted maximum likelihood procedures were used to estimate variance and covariance components, heritabilities, genetic correlations, and phenotypic correlations for first-lactation M6HTD, MY120, and MY305. Computations were conducted with ASREML (Gilmour et al., 2006) using a 3-trait mixed model. Fixed effects were herd-year-season and age at calving. Random effects were cow and residual. Cow effects were assumed to have mean zero and variance equal to the direct product of the 3 x 3 variance-covariance matrix for the 3 traits times the relationship matrix (6,667 animals). Residual effects were assumed to have mean zero and variance equal to the direct product of 3 x 3 diagonal variance-covariance matrix times an identity matrix. Prior values of genetic and residual variances for each trait were computed using single-trait analyses with the same mixed model. Predictions of additive genetic values (EBV) of cows, sires, and dams were obtained using the genetic parameters estimated here. Weighted yearly means of cow, sire, and dam EBV were used to compute genetic trends from 1982 to 2000.

Results and Discussion

Estimates of phenotypic variances were 14.40 ± 0.39 kg^2 for M6HTD, 159,300 ± 4,276 kg^2 for MY120, and 989,200 ± 2,535 kg^2 for MY305. Estimates of additive genetic variances and covariances and phenotypic covariances among C are shown in Table 1. Heritabilities ranged from low for MY305 to medium for MY120 and M6HTD and MY120 (Table 2). Genetic correlations were high and phenotypic correlations were moderate for all traits (Table 2). Standard errors for heritabilities, genetic correlations, and phenotypic correlations were low indicating that these estimates were appropriate for this Libyan population.

The genetic variance and heritability estimates for MY305 here were lower than estimates of high producing populations (Jakobsen et al., 2002; de Roos et al., 2004; Druet et al., 2005; Muir et al., 2007). However, these estimates were comparable to those obtained in populations with low to medium production levels (Carabaño et al., 1989; Strabel and Misztal, 1999; Gengler et al., 1999; Ben Gara et al., 2006; Hammami et al., 2008). Estimates of heritability for M6HTD and MY120 here were comparable to estimates obtained by Hansen et al. (1983) who used the same traits except that they used the highest of the first 6 test days instead of M6HTD as indicator of peak production. The high estimates of genetic correlations between M6HTD and MY120 with MY305 indicated that M6HTD and MY120 could be used as selection criteria for sire and cow genetic evaluation to improve MY305. This would help improve the initial screening of young bulls and early selection of cows, reduce generation interval, and increase genetic progress.

Genetic trends were mostly negative and small or near zero for cows, sires, and dams (Table 3). This suggested that either selection and breeding strategies were unsuccessful or that sires and dams were not chosen based on their EBV. In addition, the phenotypic expression of the genetic potential of the imported high performance cattle was likely reduced by the low input system and management practices in this Libyan population during the period of the study.

Conclusion

Estimates of heritabilities for M6HTD, MY120, and MY305 suggested selection for these traits would be effective in this Libyan population. High values of genetic correlations indicated that M6HTD and MY120 could be used for early screening of young sires and cows. This would shorten generation interval and increase genetic progress. Results here will help develop a comprehensive genetic evaluation and selection program for cows, sires, and dams based on estimated breeding values. This strategy could serve as a model for the development of a national genetic evaluation system for dairy cattle in Libya.

Literature Cited

Ben Gara, A., B. Rekik, and M. Bouallegue. 2006. Genetic parameters and evaluation of the Tunisian dairy cattle population for milk yield by Bayesian and BLUP analyses. Livest. Sci. 100:142-149.

Carabaño, M. J., L.D. Van Vleck, G. R. Wiggans, and R. Alenda. 1989. Estimation of genetic parameters for milk and fat yields of dairy cattle in Spain and the United States. J. Dairy Sci. 72:3013–3022.

De Roos, A. P. W., A. G. F. Harbers, G. de Jong. 2004. Random herd curves in a test-day model for milk, fat, and protein production of dairy cattle in The Netherlands. J. Dairy Sci. 87:2693–2701.

Druet, T., F. Jaffrezic, and V. Ducrocq. 2005. Estimation of genetic parameters for test day records of dairy traits in the first three lactations Genet. Sel. Evol. 37:257-271.

Gengler, N., A. Tijani, G. R. Wiggans, C. P. Van Tassell, and J. C. Philpot. 1999. Estimation of (co)variances of test day yields for first lactation Holsteins in the United States. J. Dairy Sci. 82:225.e1-225.e14.

Gilmour, A. R., B. J. Gogel, B. R. Cullis, and R. Thompson. 2009. ASReml User Guide Release 3.0. VSN International Ltd., Hemel Hempstead, HP1 1ES, UK.

Hammami, H., B. Rekik, H. Soyeurt, A. Ben Gara, and N. Gengler. 2008. Genetic Parameters for Tunisian Holsteins using a test-day random regression model. J. Dairy Sci. 91:2118–2126.

Jakobsen, J.H., P. Madsen, J. Jensen, J. Pedersen, L. G. Christensen, and D. A. Sorensen. 2002. Genetic parameters for milk production and persistency for Danish Holsteins estimated in random regression models using REML. J. Dairy Sci., 85:1607–1616.

Muir, B.L., G. Kistemaker, F. Jamrozik, and F. Canavesi. 2007. Genetic parameters for a multiple-trait multiple-lactation random regression test-day model in Italian Holsteins. J. Dairy Sci. 90:1564–1574.

Strabel, T., Misztal, I. (1999). Genetic Parameters for first and second lactation milk yields of Polish Black and White Cattle with random regression test-day models. J. Dairy Sci. 82: 2805-2810.

Table 1. Estimates of additive genetic variances (diagonal), additive genetic covariances (above diagonal) and phenotypic covariances (below diagonal) for dairy traits in a Libyan cattle population

Trait	M6HTD, kg^2	MY120, kg^2	MY305, kg^2
M6HTD	2.9 ± 0.5	332.8 ± 58.0	603.7 ± 117.4
MY120	1,256.0 ± 37.4	39,150 ± 6,788	69,150 ± 13,410
MY305	2,200.0 ± 81.3	263,800 ± 8,902	141,400 ± 32,310

Table 2. Estimates of heritabilities (diagonal), genetic correlations (above diagonal) and phenotypic correlations (below diagonal) for dairy traits in a Libyan cattle population

Trait	M6HTD	MY120	MY305
M6HTD	0.20 ± 0.04	0.99 ± 0.01	0.95 ± 0.04
MY120	0.83 ± 0.01	0.25 ± 0.04	0.93 ± 0.04
MY305	0.58 ± 0.01	0.67 ± 0.01	0.14 ± 0.03

Table 3. Estimates of cow, sire, and dam genetic trends for dairy traits in a Libyan cattle population

Trait	M6HTD, kg	MY120, kg	MY305, kg
Cows	-0.01 ± 0.01	-0.54 ± 1.65	-0.70 ± 2.78
Sires	-0.02 ± 0.01	-1.58 ± 2.22	-4.91 ± 2.30
Dams	0.00 ± 0.00	0.17 ± 0.40	-0.33 ± 1.14