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GENETIC ASPECTS FOR MILK TRAITS IN SAUDI CAMELS

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ABSTRACT

A 269 lactation records for Saudi she-camels were genetically analysed and evaluated for lactation traits of milk yield of the first three months of lactation, annual milk yield, total milk yield, length of lactation period, monthly milk yield, and daily milk yield. Data were analysed using DFREML procedure to estimate direct additive effects (i.e. direct heritabilites), permanent environment and random errors. Breeding values of camels with and without records in this population were predicted for lactation traits using an animal model.

Heritabilities were moderate and ranged from 0.08 to 0.25. Ratios of permanent environment were also moderate and ranged from 0.16 to 0.22. The ranges in breeding values for the animals with and without records were moderate or high, e.g. 166.8 kg, 1312 kg, 1436 kg, 282 day, 121.2 kg, and 3.044 kg for 3-month milk yield, annual milk yield, total milk yield, lactation period, monthly milk yield, and daily milk yield, respectively. Accuracies of breeding values recorded for lactation traits were high and ranged 0.42 to 0.76. The percentage of animals that had positive estimates of breeding values for all traits were nearly similar and ranged 53.3 to 57.30%. The rates of selection responses predicted were moderate or high where these rates were ranged from 3.1 to 9.6 % relative to the actual mean of the trait.

Key words: Animal model, genetic evaluation, heritabilities, lactation, permanent environment, saudi camels

The arab world has more than 12 million camels which is about 70% of the world camel population (Ramet, 2001). But, the share of camels in meat and milk production in arabian countries is still very low (Hermas, 1998). This is because the camel was ignored as an animal genetic resource and no genetic improvement was practiced to increase its productive potentiality. The published works concerning estimation of genetic parameters and evaluation for lactation traits in camels using updated methodologies (e.g. DFREML, GSAMP, PEST, VCE,... etc) are very limited, since most of these estimates were based on small number of records and applying old methodology (Wilson *et al*, 1990; Hermas, 1998 and 2002). Genetic improvement for milk production traits in camels could be achieved through selection and it necessitates identifying the elite she-camels and superior sires through the evaluation of animals to be selected. Evaluation of animals using animal models are nowadays, utilised in many countries all-over the world for various domestic species such as cattle and sheep. Although, surprisingly this method was almost completely ignored in camel evaluation systems.

In Saudi Arabia and during the last two decades, a common trend has been raised for establishing large-scale commercial herds of dairy and meat camels in order to increase the national milk and meat production from camels. Since that time and until now, the native camels' breeds were not genetically evaluated in aspects of productive efficiency. In an attempt to evaluate these camels, the objectives of the present study were: (1) to characterise a Saudi herd of camels for lactation performance in terms of first 3-month milk yield, annual milk yield, total milk yield, length of lactation period, monthly milk yield, and daily milk yield, (2) to estimate the effects of direct additive genetic (i.e. heritabilities), permanent maternal environment, and error for these lactation traits in this herd using an animal model, and (3) to predict the breeding values for animals of this Saudi population (i.e. she-camels with records and their parents of sires and dams without records).

Materials and Methods

Animals:

One-pedigreed Saudi camel population was

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genetically analysed and evaluated. Animals used in this study were collected from the camel herd of Range and Animal Development Research Centre, Al-Jouf region which located in the northwestern part of Saudi Arabia. Records were collected for 20 years from 1985 to 2004.

Management and feeding:

All the animals were treated and medicated similarly and they were reared under the same managerial and climatic conditions.

Camels of Al Jouf region in Saudi Arabia are usually sexually active in the colder months of a year (October till March). Natural mating was applied for all she-camels and parturitions occurred from November till April.

Hand milking was performed for lactating she-camels twice a day and the amount of milk yield was calculated individually for each animal and recorded in special records. During the last 3 years, milking machines were used for milking.

All the animals were fed *ad libitum*. Camels under investigation were fed the available roughage and concentrate pellets. Whole palin dates and bran were also offered irregularly. During the spring season, green fodders were available in the range and were allowed for the animals with concentrate supplementation.

Data collected:

All the abnormal records and those of the aborted she-camels and records without pedigree or mating dates were excluded from the present study. A total number of 269 complete lactation for 161 she-camels fathered by 8 sires and mothered by 33 dams were used. Lactation traits of milk yield of the first three months of lactation (3MMY), annual milk yield (AMY), total milk yield (TMY), length of lactation period (LP), monthly milk yield (MMY), and daily milk yield (DMY) were analysed.

Model of genetic analysis:

Data were analysed by applying programme of Boldman *et al* (1995) and using a single-trait animal model as (matrix notation):

$$Y = Xb + Z_a U_a + Z_p U_p + e$$

Where: Y = vector of lactation trait; X= incidence matrix of fixed effects; b = vector of fixed effects including parity (3 parities) and year-season of calving (winter or spring); Z_a and Z_p = incidence matrices respective to random direct additive effects and permanent environmental effects, respectively; U_a and U_p= vectors of animal random effects and random permanent environmental effects, respectively; e = vector of random errors.

Pedigree information was used as far as it existed. The relationship coefficient matrix (A^{-1}) among animals was considered in such single-trait animal model (Korhonen, 1996). Programme of Boldman *et al* (1995) was adapted to use the sparse matrix package, SPARSPAK (George and Ng, 1984). Convergence was assumed when the variance of the log-likelihood values in the simplex reached $<10^{-12}$. The occurrence of local maxima was checked by repeatedly restarting the analyses until the log-likelihood did not change beyond the first decimal. The animal model was used to estimate the proportions of direct additive genetic effects (representing heritability, h^2_a), permanent environmental effects (p^2), and error (e^2). Direct heritabilities (h^2_a) were computed as:

$$h^2_a = \sigma^2_a / (\sigma^2_a + \sigma^2_p + \sigma^2_e)$$

Where σ^2_a= direct additive genetic variance, σ^2_p= permanent environmental effects variance, and σ^2_e = error variance.

Model of genetic evaluation:

Breeding values (PBV) for milk traits of she-camels were predicted using their own records. Animals without lactation trait of their own records such as dams and sires were also evaluated. Solutions for equations of animals with (161 she-camels) and without records (8 sires and 33 dams) were computed from the pedigree file. A diagonal element (d_t) and an adjusted right-hand side (y_t) were accumulated with each pedigree file record for the t[th] animal. According to Kennedy (1989), the formula used to predict the breeding values (PBV) was: PBV = $[y_t/d_t]$; where y_t/d_t = breeding values of the animals. The accuracy of breeding value predicted for each animal was estimated according to Henderson (1975) to be as: $r_A = \sqrt{1 + F_i = d\ _i\alpha_a}$ Where r_A=the accuracy of predicted breeding value for the i[th] animal; F_j= inbreeding coefficient of animals; d_j= the j[th] diagonal element of inverse in the appropriate block coefficient matrix; and $\alpha = \sigma^2_e/\sigma^2_a$. Standard error (SE) of predicted breeding value for each animal was estimated to be as: $^{SE}{}_{PBV} = d_j\sigma^2_e$ Where d^j and σ^2_e were defined before.

Results and Discussion

Means and variations:

Means, standard deviations and ranges in phenotypic variations for lactational performance of Saudi camels are presented in table 1. These figures in

Table 3. Minimum and maximum estimates of predicted breeding values (PBV) and their standard errors (SE) for milk traits along with accuracy of prediction (r_A) in Saudi camels

Lactation trait+	Minimum			Maximum			Range	RRM++
	PBV	SE	r_A	PBV	SE	r_A		
3MMY, kg	-82.6	12.6	0.76	84.0	14.8	0.74	166.8	71.1
AMY, kg	-452	68.7	0.72	860	72.4	0.68	1312	68.1
TMY, kg	-816	158	0.64	820	142	0.58	1436	60.5
MMY, kg	-58.6	4.8	0.62	62.6	6.2	0.56	121.2	77.1
DMY, kg	-1.426	0.345	0.66	1.618	0.265	0.59	3.044	58.1
LP, day	-156	36.8	0.46	126	26.4	0.42	282	62.8

+ Traits were defined in Table 1.

++ RRM= Range in PBV relative to the actual mean of milk trait. Number of camels with and without records evaluated was 202.

cattle raised in Egypt reported that the ranges in breeding value in the first, second, and third lactation were 552.9, 435.0, and 491.3 kg for 305-day milk yield and 704.5, 736.3 and 587.5 kg for TMY, and 46.1, 49.3 and 56.3 for lactation period, respectively.

Accuracies (r_A) of minimum and maximum estimates of PBV recorded for lactational performance of the animals were moderate or high (Table 3). These accuracies ranged from 0.42 to 0.76. In recent study, to compare accuracy and precision of variance components and breeding values for international genetic evaluations based on national breeding values or animal performance records, Fikse (2004) stated that correlations between true breeding values were high (>0.90) which may explain the small differences in root mean squares of predicted breeding values of animals.

Animals with positive breeding values

For 3MMY, AMY, TMY, LP, MMY, and DMY, the percentages of animals (she-camels and their dams and sires) that have positive estimates of breeding values were 57.9, 57.3, 54.3, 56.3, 56.4, and 53.3%, respectively. These percentages indicate that the Saudi herd under investigation recorded high percentages of animals with positive signs for milk traits; *i.e.* the top 56% of the animals above the herd average to be selected all had positive breeding values. For sires evaluated recently across countries in a large project in Australia, Belgium, Canada, Czech Republic, Finland, Germany, Hungary, Ireland, Israel, Italy, Netherlands, New Zealand, South Africa and USA, Maltecca *et al* (2004) reported that the mean numbers of common sires among the top 25, 100 and 250 sires selected on estimated breeding values were 11, 48 and 154 for single-trait animal model and 16, 66 and 176 for multiple-trait animal model, respectively.

Estimates with positive breeding values for she-camels of the present study suggest that early selection of she-camels themselves according to their lactational performance during the first three months of lactations (i.e. 3MMY) could be an effective method to improve milk traits in camels under the Saudi conditions. In North and South America, Abubakar *et al* (1987) noted that 47% of the sires had positive predicted sire values for 305-day milk yield in both Mexico and Colombia. In the Arabian area, Afifi *et al* (1992) found that the positive percentages of breeding values for 305-day milk yield in the first, second and the third lactation were 50.0, 45.6 and 51.0%, respectively, while they were 43.4, 43.2 and 51.0 for total milk yield and 49.1, 47.3 and 46.9% for lactation period. Afifi *et al* (2002) found that the percentage of the positive breeding values for 305-day milk yield was 53.0%.

Additive selection responses predicted per generation (SR_A):

For the list of all Saudi camels with and without records in the present herd, the direct additive selection responses per generation (SR_A) for lactation traits are presented in table 4. These predicted estimates were nearly similar for different traits of lactation. Also these rates of selection responses predicted were moderate or high, ranging from 3.1 to 9.6 % relative to the actual mean of the trait.

Conclusions

- This is the first attempt to characterise Saudi camels genetically for lactation traits using updated methodology. An animal model including the fixed effects together with the permanent environmental effects will be recommendable to be applied in genetic evaluation programs for dairy camels. Although animal rankings will differ slightly among methodologies used, it appears that other factors, such as quality of the performance data or accuracy of the pedigree information may have

Table 1. Actual means, standard deviations (SD), and ranges for milk traits in Saudi camels

Lactation trait	Abbreviation	Mean	SD	Minimum	Maximum	CV%⁺
First three months milk yield, kg	3MMY	234.5	62.2	103	493	26.5
Annual milk yield, kg	AMY	1927	483	498	3630	25.1
Total milk yield, kg	TMY	2373	740	524	5428	31.2
Monthly milk yield, kg	MMY	157.2	40.1	40.3	301.6	25.2
Daily milk yield, kg	DMY	5.239	1.337	1.344	10.050	25.5
Lactation length, day	LP	449	54	390	540	12.2

⁺CV = Coefficient of variation

Saudi camels generally fell within the range of those estimates obtained in most of the Arabian studies (Ismail and Al-Mutairi, 1991; Wardeh *et al*, 1991; Hermas, 1998 and 2002).

Percentages of phenotypic variation for milk traits in Saudi camels were moderate or high; ranging from 12.2 to 31.2 % (Table 1). Literatures suggest that phenotypic variations among breeds in milk traits are of considerable importance (Morton, 1991; Bachmann and Schulthess, 1987; Ismail and Al-Mutairi, 1991; Wardeh *et al*, 1991; Hermas, 1998 and 2002; Aslam *et al*, 2002). However, genetic potentiality of camel breeds for milk production has not been fully exploited because selective pressure of humans on the camels, milk has a minimal trend compared with the other domestic animals (Ramet, 2001).

Genetic analysis for milk traits:

Proportions of direct additive effects (heritabilities, h^2_a), permanent environmental effects (p^2) and error (e^2) associated with their standard errors (SE) for lactation traits in Saudi camels are presented in table 2. However, estimates of random error for milk traits recorded for Saudi camels were high and ranged 0.54 to 0.72. For lactation length, estimate of heritability was low (0.08) which is lower than estimate of 0.31 obtained by Hermas (2002) for Libyan camel. But, direct heritabilities and permanent environmental effects for milk yield traits were moderate (Table 2) and ranged 0.22 to 0.25 and from 0.16 to 0.22, respectively. These results indicate that lactation traits in camels of the present study were subjected to high variabilities due to the permanent environmental effects. This trend may be due to the fact that Saudi camels were not imposed to intensive selection programs. However, the moderate estimates of heritability obtained here indicate that improvement of milk traits could be possibly achieved through selection.

Table 2. Proportions of direct additive effects (direct heritabilities, h^2_a), permanent environmental effects (p^2) and error (e^2) for lactation traits in Saudi camels

Lactation trait⁺	h^2_a±SE	p^2±SE	e^2±SE
3MMY	0.24±0.11	0.22±0.14	0.54±0.09
AMY	0.25±0.09	0.17±0.15	0.58±0.11
TMY	0.22±0.09	0.20±0.11	0.58±0.12
MMY	0.22±0.12	0.18±0.08	0.60±0.12
DMY	0.25±0.12	0.16±0.12	0.59±0.12
LP	0.08±0.14	0.20±0.12	0.72±0.13

⁺Traits were defined in Table 1.

Genetic evaluation of animals for milk traits:

Since mating between animals in the present study was random. An important advantage of using an animal model instead of a sire model for prediction of breeding values was evidenced recently by Fikse (2004). More evidence of using animal models commonly to predict the breeding values in Europe was reported by Interbull' programme (Interbull, 2005). In the present study, the minimum and maximum estimates of breeding value (PBV) predicted for milk traits using an animal model and their standard errors (SE) and accuracy of each predictor are presented in table 3. The ranges in estimates of breeding values relative to the actual mean of the lactation trait (Table 3) indicate that 3-month milk yield recorded the highest range (71.1%) among all milk traits, i.e. improvement of lactational performance of Saudi she-camels at an early age could be achieved through selection. For the list of all animals, the ranges in breeding value estimated in this population of camels were moderate or high. These ranges were 166.8 kg, 1312 kg, 1436 kg, 282 day, 121.2 kg, and 3.044 kg for 3MMY, AMY, TMY, LP, MMY, and DMY, respectively. In camels, estimates of breeding values are not available in literature for comparison with estimates of the present study. In USA, Mexico and Colombia, Aboubakar *et al* (1987) reported that the ranges in breeding value for 305-day milk yield were 792, 733 and 542 kg, respectively. Rozzi *et al* (1990) found that ranges in breeding value for milk yield were 156, 544 and 151 kg for Holstien cattle raised in Canada, USA and Italy, respectively. Afifi *et al* (1992) with Friesian

Table 4. Percentages of animals having positive breeding values and additive selection responses predicted per generation (SR_A) for lactation traits in Saudi camels

Lactation trait⁺	Animals with positive breeding values (%)	SR_A (kg)	SR_A (%)⁺⁺
3MMY	57.9	22.6	9.6
AMY	57.3	165.0	8.6
TMY	54.3	195	8.2
MMY	56.4	12.2	7.8
DMY	53.3	0.386	7.4
LP	56.3	14.1	3.1

⁺ Traits were defined in Table 1.

⁺⁺SR_A = The rates of selection responses predicted relative to the actual mean of the trait.

larger impact on the accuracy of genetic predictors than the choice of methodologies.

- The moderate or relatively high estimates of heritability and breeding values obtained in the present study for milk traits could be an encouraging factor for the decision makers to plan a selection policy to improve the lactational performance in Saudi camels at an early stage during the first three months of lactation.

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