ESTIMATES OF HERITABILITY AND CORRELATION FOR MILK AND GROWTH TRAITS IN ZARAIBI GOAT

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SUMMARY

Records from the El-Serw research station belonging to Animal Production Research Institute were used to estimate the genetic parameters for the economically most important milk and growth traits in the Zaraibi goat breed. There were 99 and 110 half-sib families over the periods 1995-2003 and 1990-2003 for milk and growth traits, respectively. Milk traits were, milk yield during the first 90 days and the total yield and the length of lactation period. The weight was recorded at birth, 90, 180 and 365 days of age. Mixed model methodology based on a multi-trait animal model was used to estimate the genetic and phenotypic parameters. A repeatability model was used for milk traits. Heritability for milk yield was 0.27 (90 days) and 0.35 (total) with a genetic correlation of 0.89 between them. The lactation period had heritability 0.15 and it was naturally positively correlated with yield, especially with the total yield (0.80). Therefore a selection program on the earlier 90 days yield record would give the best annual genetic changes for milk traits. The heritability for weight traits varied between 0.12 and 0.33 with high (0.42-0.82) positive genetic correlations between them. The pre-weaning gain (from birth to 90 days) is a very useful tool for selection, as it has a satisfactory heritability (0.33), it is very highly correlated with the post-weaning gain (from weaning to 6 months) and it is available well before any selection decisions are made.

Keywords: Multiple traits, animal model, genetic parameters, growth and milk production traits, Zaraibi goat

INTRODUCTION

Goats are an important source of meat in Egypt. One of the better known native breeds is Zaraibi goat, also called Egyptian Nubian. Although, the population size is small (2% of the total goat population in Egypt), the breed has a good reputation in Egypt and the Near East region, because of its high prolificacy and milk production (Galal *et al.*, 2005). Some authors reported this breed to be a progenitor for the standard international Anglo-Nubian breed (Devendra and McLeroy, 1982 and Gall, 1981).

The aim of this study was to estimate the genetic and phenotypic parameters for economically the most important milk and growth traits for using these estimates in developing a selection programme for the Zaraibi goats.

MATERIALS AND METHODS

1. Breed characterization

Zaraibi goat is a promising goat breed in Egypt. At present the breed mainly exists in the North East of the Nile Delta. Some animals could be found as household goats in the north-eastern Delta, kept as a hobby rather than productive flocks. The breed is also called Nubian or Nubi, after Nuba in Upper Egypt. It is hard to find these goats now in southern Egypt. The total population for the breed is about 56,000 head and the breed is considered to be at risk (Galal *et al.*, 2005). The body is long and deep with long legs. The average body length, height at withers and heart girth in females is 70.4, 69.4 and 73.3 cm, respectively (Abdel-Monaam, 1986). The head is big and it has a distinctive convex profile with a Roman nose and with many animals having an undershot jaw. Animal of either sex rarely has horns. The ears are broad, long, pendulous and drooping, sometimes with a fold at the tip', especially in young kids. Body color is very variable from cream to red, black, brown or mixture of these and sometimes with white spots. The body is covered with short hair (Galal *et al.*, 2005).

2. Herd management

This study was carried out on the Zaraibi goat herd kept at El-Serw experimental station located in the north-eastern part of the Nile Delta. The research station belongs to the Animal Production Research Institute of Agriculture Research Center at the Ministry of Agriculture. Animals were housed in semi-open pens and fed on Egyptian clover (*Trifolum alexandrinum*) from December to May. For the rest of the year they fed on rice straw and green fodder, if available, as an addition to concentrate mixture.

The composition of the concentrate mixture was cotton seed cake, maize, wheat barn, rice barn, calcium carbonate and sodium chloride with an average composition of 16% crude protein, 3% crude fat and 15% crude fiber on average. Does were supplemented with half a kilogram concentrate mixture per day for two weeks before the mating season and from the second to the fourth week of pregnancy. Moreover, milking goats were supplemented with one kg of concentrate mixture daily. Water is offered twice a day in early morning and late afternoon.

There was one mating season per year (October) from year 1990 until 1992 and starting from year 1993, the herd was divided into two groups for two mating seasons per year (June and October). Does were randomly divided into mating groups of 30-35 does and each was randomly assigned to a fertile buck. Mating period lasted for 45 days. Does were first joined with the buck at the age of approximately 18 months. At kidding, newborns were identified and their type of birth, gender and pedigree were recorded. Weight was recorded within twenty-four hours after birth and then at 30-day intervals. Kids were weaned at approximately 90 days of age.

3. Data

3.1. Milk production traits: A total of 2363 lactation records obtained from 975 does, progeny of 99 sires and 571 dams were used in this study. Data were collected from October 1995 to October 2003. Milk production traits were measured as total milk yield (TMY), milk yield up to 90 days (MY90) and lactation period (LP). Milk production of does was recorded daily after kidding until drying off. Morning milk

yield was measured during the suckling period by isolating kids from their dams at 5.00 pm and then weighed on the following morning at 8.00 am, and allowed to suckle their dams until satisfaction, the increase in kids weight after each suckling was considered as their milk consumption. The does were hand milked in order to estimate residual milk (stripped milk). The sum of suckled and stripped milk represents the quantity of the morning milk yield. Similar procedure was followed in estimating the evening milk production. The sum of morning and evening milk production represented daily milk production.

After weaning, does were machine milked twice a day at 8.00 am and at 5.00 pm. Does were considered dry when their daily milk yield dropped to 100 g a day.

Milk yield up to 90 days was calculated by summing daily milk yield up to 90 days after kidding. Total milk yield was calculated as the sum of milk during suckling period and milking period. The lactation period was the interval between kidding date and drying off date.

3.2. Growth traits: Data were collected on 6755 Zaraibi kids progeny of 110 sires and 1331 dams, during the period from 1990-2003.

Six body weight traits were measured in this study, weight at birth (WB), 90 days (W90-D), 180 days (W180-D), 365 days (W365-D), pre-weaning (PRW) and post-weaning daily gain (PSW). Weight at birth was recorded within 24 hours after kidding. Kids were kept with their dams all the time until weaning. Weaning weight was recorded at 90 days of age. Kids were weighed monthly after kidding till 18 months of age. Weights were adjusted to 90, 180 and 365 days of age by intrapolating linearly the recorded weight to the weight of the designated age.

Pre-weaning daily gain (g/d) was calculated as the difference between birth weight and live weight at 90 days of age (weaning weight) divided by number of days from birth up to weaning while, post weaning daily gain (g/d) was calculated from the difference between weaning weight at 90 days and live weight at 180 days divided by number of days from weaning up to 180 days of age.

4. Statistical analysis

(Co)variance components for the traits were estimated with a multi-trait analysis using the models described in Table 1. A derivative-free REML algorithm (DFREML, Graser *et al.*, 1987) using computer program of Boldman *et al.* (1995) was used to estimate (co)variance components. Local convergence was considered attained when the variance of the -2 log likelihood in the simplex was less than 10^{-6}. Global convergence was considered attained when the -2 log likelihood did not change to the third decimal after restarting.

4.1. Milk production traits: The fixed effects on milk production traits included in the model were litter size (single, twins and triplets or more), season of kidding (winter and autumn), doe parity (1, 2, 3, 4, 5, 6 and 7) and year of kidding (1995, 1996,...2003)

The assumed model was:

$$Y = X\beta + Z_a a + Z_c c + e \qquad \text{(Model 1)}$$

Where,

Y   is vector of observations;

X   the incidence matrix for fixed effects;

β   the vector of an overall mean and fixed effects of litter size, season of kidding, doe parity and year of kidding

Z   the incidence matrix for random effects;

a   the vector of additive genetic effect;

c   the vector of permanent environmental effect ;and

e   the vector of random errors $\sim N(0, I \sigma^2_e)$ where I is identity matrix and the residual variance is σ^2_e.

4.2. Growth traits: The fixed effects on growth traits were type of birth (single, twins, triplets or more), gender (male and female), age of doe at kidding (≤ 24, >24-36, >36-48, >48-60 and > 60 months) and year-season of birth (1, 2, 3, ...25).

The assumed model was:

$$Y = X\beta + Za + e \qquad \text{(Model 2)}$$

Where,

Y   the vector of observations;

X   the incidence matrix for fixed effects;

β   the vector of an overall mean and fixed effects of type of birth, gender of kids, age of doe and year-season of birth;

Z   the incidence matrix for random effect (additive genetic effect);

a   the vector of additive genetic effect; and

e   the vector of random errors $\sim N(0, I \sigma^2_e)$ where I is identity matrix and the residual variance is σ^2_e.

Table 1. Description of fixed and random effects in animal models for milk and growth traits

Traits	Fixed Effects	Random Effects
Milk traits	Litter size, Parity number, Season of kidding, Year of kidding	Animal additive genetic (doe) Permanent environmental (doe)
Growth traits	Age of dam, Gender of kid, Type of birth, Year-season of birth	Animal additive genetic (kid)

RESULTS AND DISCUSSIONS

1. Milk production traits

The overall mean of TMY was 263.0 kg, 135.8 kg for MY90 and 262 days for LP. Estimates of additive genetic and permanent environmental variance for milk production traits are shown in 2.

Table 2. Estimates of heritability (on diagonal), genetic correlations (above diagonal) and phenotypic correlations (below diagonal) for TMY, MY90 and LP

Traits	TMY	MY90	LP
TMY	0.35	0.89	0.80
MY90	0.67	0.27	0.46
LP	0.70	0.14	0.15
Additive genetic variance	2045.12	284.45	582.89
Environmental variance	4258.30	886.88	3148.19

1.1. Heritability: Heritability estimates for milk production traits are presented in Table 2. The results showed that heritability was moderate for milk yield traits but low for lactation period (Table 2). Heritability estimate obtained in this study for total milk yield (0.35) is higher than the finding of Abdel-Raheem (1998) who worked on a part of the data used in the present study and reported a value of 0.10. Moreover, other authors working on various breeds of goat have found different estimates being 0.14, 0.29, 0.18 and 0.24 reported by Kominakis *et al.* (2000) for Skopelos goat; Eissa (1996) on Damascus goat; Analla *et al.* (1995) for Granadina goat and Rabasco *et al.* (1993) for Verata goat, respectively. However, Grossman *et al.* (1986) reported higher estimates of heritability for total milk yield in Alpine, LaMancha, Nubian, Saanen, and Toggenburg goat breeds and gave figures 0.42, 0.38, 0.45, 0.44 and 0.41, respectively.

Estimate of heritability for milk yield for MY90 in this study (0.27) is in the neighborhood of the estimate of 0.29 reported by Constantinou and Mavrogenis (1987) for Damascus goats. While it is lower than that reported by Constantinou *et al.* (1985) of 0.35 for Damascus goats. Abdel-Raheem (1998) and El-Saied *et al.* (1998) reported lower estimates of heritability (0.03 and 0.02) for lactation period than that obtained in the present study (0.15). However, higher estimates were reported by Eissa (1996) for Damascus and Barki goats of 0.25 and 0.20, respectively.

The high estimates of heritability for milk yield traits obtained in this study indicate that the procedure used to measure the yield is accurate enough, especially early measurement done with the suckling kids gives also satisfactory results in this respect and it could be used as a criterion in an effective selection program.

1.2. Repeatability: The same pattern was found for the repeatability estimates for milk yield traits as that for heritability. The estimate of repeatability for total milk yield was 0.43, which is close to those published by Grossman *et al.* (1986) of 0.44 in Saanen goat and Iloeje *et al.* (1981) of 0.42 in Toggenburg goat.

Our estimates are higher than 0.29, 0.32 and 0.20 obtained by Portolano *et al.* (2001) with Barbaresca goat; Mourad (2001) with Alpine goat and Abdel-Raheem (1998) with Zaraibi goat, respectively.

Estimate of repeatability for milk yield up to 90 days found in this study (0.33) was lower than 0.49 calculated by Constantinou (1989) in Damascus goat. Furthermore, repeatability estimate for lactation period in the present study of 0.22, is similar to those reported by Eissa (1996) in Barki goat and Carcia (1985) in Criallo crossbred goats but higher than 0.05 reported by Abdel-Raheem (1998) on Zaraibi goat and lower than 0.72 and 0.29 reported by Mourad (2001) on Alpine goat and Portolano *et al.* (2001) on Barbaresca goat.

The obtained repeatability values speak for the satisfactory accuracy of milk yield records, as stated in the context of heritability estimation.

1.3. Genetic and phenotypic correlations: The genetic and phenotypic correlations between milk production traits are shown in Table 2. Results of genetic correlation show high and positive estimates especially between TMY and both MY90 and LP (0.89 and 0.80). These estimates are close to those reported by Portolano *et al.* (2001) and Kominakis *et al.* (2000). In contrast, the genetic correlation between MY90 and LP was moderate (0.46). As the correlation was much higher with the total milk yield and LP, this implies there is also genetic variation for the shape of lactation

curve in Zaraibi goats, in the same way as found in dairy cattle (Lidauar *et al*, 2003). Hence before an efficient selection program benefiting from an early indicator of 90 days milk yield is established, some information is needed on the variation in lactation curves. When several records per lactation are available, even test-day model evaluation exploiting all the different records and producing estimates for the shape of lactation curve and very early predictors for the total milk yield can be considered (Lidauar *et al.*, 2003).

Phenotypic correlations between milk production traits were moderate (Table 2) and show the same trend as for the genetic correlations. There was a low phenotypic correlation between MY90 and LP being 0.14, not surprising after was found for the genetic one. The explanations and implications would be the same as discussed on the genetic correlation.

2. Growth traits

The overall means for studied growth traits were 2.0, 10.7, 16.0 and 24.2 kg for WB, W90-D, W180-D and W365-D, respectively and 96.8 and 60.0 g/d for PRW and PSW, respectively.

2.1. Heritability: Heritability estimate of body weight and weight gain decreased over age (Table 3). Heritability estimates for all studied weight traits are lower than those reported for the same herd by Shaat *et al.* (2005) and Mekkawy (2000) or breeds like Black Bengal and Jamnapari goats (Singh, 1997) and Angora goats (Hermiz *et al.*, 1997).

Table 3. Estimates of heritability (on diagonal), genetic correlations (above diagonal) and phenotypic correlations (below diagonal) for Zaraibi growth traits

Traits	WB	W90-D	W180-D	W365-D	PRW	PSW
WB	0.21	0.42	0.47	0.62	0.18	0.10
W90-D	0.13	0.16	0.77	0.82	0.47	0.33
W180-D	0.21	0.59	0.12	0.77	0.41	0.29
W365-D	0.25	0.50	0.62	0.12	0.40	0.26
PRW	0.11	0.37	0.29	0.33	0.33	0.99
PSW	0.11	0.02	0.30	0.32	0.99	0.28
Additive genetic variance	0.06	0.85	0.78	0.78	0.09	0.03
Environmental variance	0.21	4.53	5.75	5.83	0.17	0.07

The differences in heritability estimates could be due to the different methods used for the estimation and the population sampled. A preliminary analysis of the present data used in this study showed that the single trait analysis using MTDFREML programme resulted in higher estimates of heritability than when using the multi trait analysis. On the other hand, the heritability estimates for daily gain traits obtained in this study (Table 3) are higher than those reported by Singh (1997)

with Black Bengal; Bata (1989) with Zaraibi and Mavrogenis *et al.* (1984) with Damascus goats.

However, they are lower than the figures given by Al-Shorepy *et al.* (2002) with Emirati goats. The gain traits are more important in selection and the results are indicating that the research station data would be sufficient for carrying out an efficient genetic improvement scheme in the economically important meat production trait.

2.2. Genetic and phenotypic correlations:

There are strong positive genetic correlations between weight traits (W90-D, W180-D, and W360-D). The genetic correlation was moderate between weights at birth (WB) and later age (Table 3). Possibly the dam is more important in determining the birth weight than the animal itself. The present findings are in good agreement with those for Zaraibi (Shaat *et al.*, 2005; Mekkawy 2000), Common African x Alpine (Mourad and Anous 1991) and Black Bengal goats (Singh 1997). Phenotypic correlations for weight traits (Table 3) ranged from low to medium according to the age, while it was high (0.99) between the daily gain traits (PRW and PSW).

The strong positive genetic correlation (0.99) between the daily gain traits indicate that genes responsible for the phenotypic expression of pre-weaning daily gain were also responsible for expression of post-weaning daily gain. Therefore, selection for the PRW trait will improve the PSW trait as well and selection can be made at an early stage of age.

CONCLUSIONS

The research station herd proved to provide a satisfactory body of data for estimating the genetic parameters. The obtained results are in agreement with earlier studies in Zaraibi goat and with those found in other goat breeds. We were not able to present the standard errors for the estimates. However, as the number of half-sib families for both the traits was close to one hundred and the obtained values were from moderate to high, then e.g. the standard error of the heritability estimate for growth traits would be very small indeed, of the order 10^{-3} (Falconer and Mackay, 1996).

Meat production is economically the most important trait in Zaraibi goats and therefore the first priority in genetic improvement program is to construct an efficient selection scheme for the trait. The most feasible scheme would be to base the information flow and the operations within few herds. The relatively cheap measurements routines used in a few herd research stations seem to be sufficient to reveal the genetic differences between animals. When the operations are done in few production environments, the management is uniform and could be well controlled. One or few breeding units can then distribute breeding animals for a wider use in production herds.

The high genetic correlation (0.99) between PRW and PSW indicates that selection for the PRW will improve also PSW and thereby selection can be made at an early stage of age. The genetic and phenotypic parameters obtained in this study can be used in a breeding scheme and in the construction of selection index. However, it will be necessary to study the maternal effect and its relationship with

the direct effect and the correlations between milk and growth traits. This study gives clear indications about the good potential to improve the milk production of does or in other words about the maternal component in the early growth of kids. The overall index for meat production would then be made of weight gain and milk production (or maternal component).

If we are interested in the milk production itself, the relatively high estimate of heritability of TMY indicates that selection for this trait is most likely effective. The 90 days yield seems to a good genetic predictor for the total milk yield. When the selection on growth traits can be done very early, it is possible to synchronize the selection scheme for milk production with this by using the 90 days milk records.

There were also some suggestions in the results that substantial variation exists in the shape of lactation curve. Therefore before any genetic improvement is founded for a dairy type Zaraibi goat, we need more information on the genetic variation in lactation curve parameters. The current recording frequency is sufficient for carrying such an analysis.

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تقديرات المكافئ الوراثي والارتباط لصفات اللبن والنمو في الماعز الزرايبي

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إستُخدم في هذه الدراسة سجلات من محطة السرو التابعة لمعهد بحوث الإنتاج الحيـواني وذلك لتقـدير المقاييس الوراثية لصفات اللبن والنمو ذات الأهمية الاقتصادية لسلالة الماعز الزرايبي. تم تجميع البيانات لأبنـاء عدد 90 و 110 عائلات أنصاف أشقة خلال الفترة من سنة 1995 الى سنة 2003 ومن سنة 1990 الى سـنة 2003 لصفات اللبن والنمو على الترتيب. تضمنت صفات اللبن كلاً من محصول اللبن الكلي ومحصول اللبن حتى 90 يوما وطول فترة الحليب بينما اشتملت صفات النمو على أوزان الجداء عند الميلاد ، 90 يوماً، 180 يومـاً، 365 يوما وكذا معدل النمو اليومي من الميلاد وحتى الفطام (معدل النمو قبل الفطام) و معدل النمو اليـومي مـن الفطام حتى 180 يوما (معدل النمو بعدا لفطام). تم استخدام نموذج الحيوان المتعدد الصــفات لتقــدير المعــايير الوراثية والمظهرية. أشارت النتائج إلى أن تقديرات المكافئ الوراثي لمحصول اللبن الكلي ومحصول اللبن حتـى 90 يوما وطول فترة الحليب كانت كالتالي 0,35 و0,27 و 0,15 بينما كان المعامل التكـراري 0,43 و 0,33 و 0,22 علي الترتيب، وكان الارتباط الوراثي مرتفعاً بين محصول اللبن الكلي وكل من محصول اللبن حتـى 90 يوما وطول فترة الحليب (0,89 و 0,80 علي التوالي) بينما كان منخفضا بين محصول اللبن حتـى 90 يومـا وطول فترة الحليب (0,14) ولهذا يمكن بمكن القول بأن ارتفاع المكافئ الوراثي لمحصول اللبن الكلي يزيد من فعالية الانتخاب وخاصة مع ارتفاع قيمة الارتباط الوراثي الموجب بينه وبين صفات اللبن الأخرى. تراوحت تقـديرات المكافئ الوراثي لصفات الوزن من 0,12 وحتى 0,33 وكان الارتباط الوراثي لصفات الـوزن عـالي وموجـب (0,42 – 0,82) بينما كان مرتفعاً (0,99) بين معدل النمو قبل الفطام وبعده، وهذا الارتباط الوراثي العالي يجعل الانتخاب المبكر لمعدل النمو قبل الفطام يحسن من صفة معدل النمو بعد الفطام.