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Covariation between milk yield and maternally affected meat production traits in goats

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Summary

Multi-trait analyses were carried out to quantify the (co)variation in meat and milk production traits in Zaraibi goats. The data was obtained from a research station. There were birth weight records on 6610 kids, of which 5970 and 5237 had also pre- and post-weaning gain record, respectively. The kids were progeny of 115 bucks and 1387 does, which had altogether 3603 litter size and milk yield records in different parities and which were daughters of 109 sires and 721 dams. The maternal genetic component was important for the genetic variation of birth weight and pre-weaning gain. The genetic correlation between direct and maternal effects within these traits was favorable (0.30 and 0.43, respectively). Heritability (repeatability) for 90-d and total milk yield was 0.26 and 0.28 (0.29 and 0.39), respectively. The correlation between the milk yield and the maternal genetic effects for the pre-weaning gain was very high (0.90). Selection schemes aiming to improve meat (litter size and growth) and milk production simultaneously are feasible. The increased milk production serves also for the acceleration of early growth in kids.

Introduction

Goats are an important source of meat in Egypt and contribute about 5 % of all the red meat in the country (Galal et al. 2005). Milk is also an important product from goats, although goat milk represents less than 1% of the total milk production in Egypt (Soryal and Metawi, 2000). The Zaraibi breed is one of the most important local goat breeds in Egypt and it has recently been a target for a genetic improvement scheme. The breed has good potential in prolificacy and milk production (Galal et al. 2005).Early growth is important for the profitability in meat production. The growth rate until weaning is determined not only by the animal's own genetic potential but also by the maternal environment. The maternal effects are composed of the dam's milk production and mothering ability, in addition to the basic contributions from uterine environment and cytoplasmic inheritance.

The objectives in our study were to estimate the genetic variation in the most important traits affecting meat production in the Zaraibi breed in Egypt. The statistical analyses for birth weight and growth were extended to include also the maternal effect. As there were also records available on milk production, it was possible to estimate the genetic correlation between daily gain of kids and the milk production of dams and thereby to find out to what extend the variation in the maternal effects coincides with that of milk traits.

Material and methods

Animals

The Zaraibi goats in the study were from the herd kept at El-Serw experimental station located in the northeastern part of the Nile delta under APRI (Animal Production Research Institute of the Agriculture Research Center within the Ministry of Agriculture).

Data recording

Data for meat traits were collected on 6610 kids in the years from 1990 to 2003. The kids were progeny of 115 sires and 1387 dams. Traits measured were body weight at birth (BW for all the kids), pre-weaning (PRW for 5970 kids) and post-weaning (PSW for 5237 kids) daily gain. The growth rate PRW was the average daily gain in the period from birth to 90 d of age and PSW the gain from 90 to 180 d of age. For milk traits, 3603 lactation records were obtained from 1380 does over the period from October 1995 to October 2003. The does were progeny of 109 sires and 721 dams.

Data analysis

Variance and covariance components for the studied traits were estimated with a multi-trait analysis using the AI-REML algorithm (Gilmour *et al.* 1995) implemented in the DMU package (version 6, release 4.6) (Madsen and Jensen 2006). First a single traits analysis was performed for all the traits and the results were used as the starting values for the multi-trait analysis. The model for total and 90-d milk yield and litter size was:

$$\mathbf{y} = \mathbf{X\beta} + \mathbf{Z_a\, a} + \mathbf{Z_p\, p_e} + \mathbf{e}$$

where $\mathbf{y}$ is vector of observations for the trait; $\mathbf{X}$ is the incidence matrix that relates data to the vector of fixed effects $\boldsymbol{\beta}$. Incidence matrix $\mathbf{Z_a}$ relates data to the vector of random genetic effect ($\mathbf{a}$) and $\mathbf{Z_p}$ to the vector of random common environmental effects ($\mathbf{p_e}$) over parities. Fixed effects on milk production and litter size traits included in the model were year of kidding (1995, 1996, ..., 2003), season of kidding (winter or autumn) and doe parity (1, 2, ..., 7). The days open was not necessary as the conception rate is very high and does are kidding regularly. The fixed effects for birth weight and daily gain were type of birth (1 = single, 2 = twins, 3 = triplets, 4 = quadruplets or more), sex of kid (male, female), age of doe at kidding (≤ 24, >24-36, >36-48, >48-60, >60 months) and year-season of birth (1, 2, 3,.. , 25 over the 14-year period). The model for these traits was:

$$\mathbf{y} = \mathbf{X\beta} + \mathbf{Z_d\, a} + \mathbf{Z_m\, m} + \mathbf{Z_m\, p_m} + \mathbf{e}$$

where $\mathbf{a}$ is now the vector of animals' direct genetic effects with respective incidence matrix $\mathbf{Z_d}$, $\mathbf{m}$ is the vector for dams' maternal genetic effects related to the data with the incidence matrix $\mathbf{Z_m}$ and the same matrix relates the vector of permanent maternal environmental effects ($\mathbf{p_m}$) to the data.

Results and discussions

Growth traits

All the analyses included the estimation of maternal component for BW, PRW and PSW. In general, direct heritability was low for the growth traits PRW and PSW, being 0.03-0.04 and 0.08-0.09, respectively. The low estimates of heritability for growth traits found in this study can be explained by the low nutritional level and unavailability of the green fodder at the goat experimental station, resulting in large environmental variations. For daily gain traits and BW, maternal heritability was of the same order as the direct heritability. The correlation between direct and maternal genetic effects (r_{am}) within trait was positive in BW and PSW and varied from positive to negative in PRW (Table 3).

These correlations ranged from -0.11 to 0.48. In BW and PSW the correlation between direct and maternal effects within a trait is favourable, suggesting that selection for increasing body weight of kids would also improve the maternal ability of the doe.

The phenotypic correlation between birth weight and early growth was low (0.10) (Table 5). There is genetic antagonism between birth weight and early growth for direct effects (-0.24) while both the respective maternal correlation and the correlations between maternal and direct effects are positive. The correlation of permanent environmental effects due to doe was close to zero between birth weight and early growth and highly negative (-0.87) between the growth traits. Regarding the genetic part of the variation, for the pre-weaning and post-weaning gain traits, the correlation between the direct effects and between the maternal effects were zero while those between the direct and maternal effect were both high and positive (Table 5).

Milk and litter size traits

Heritability and repeatability estimates for milk production traits were moderate being 0.16-0.23 and 0.28 for 90-d milk yield and 0.23-0.24 and 0.39-0.40 for total milk yield, respectively. The repeatabilities were of the level commonly found and hence indicated that the milk recording was accurate. The correlation of the permanent environmental effects between the two milk yield traits was 0.69. The genetic correlation between 90-d and total milk yield is very high (0.97). The heritability and repeatability estimate for litter size was 0.04-0.05 and 0.10-0.11, respectively. The correlation between the permanent environmental effects of milk yield traits and litter size was 0.05-0.21, a range which is lower than the respective correlation between 90-d and total milk yield (0.69). The genetic correlation of litter size with yield traits was positive (0.22-0.45). Hence the selection on either trait would not hamper the progress in the other one.

Correlation between milk and growth traits

The present study included records for milk yield, so it was possible to estimate the correlation between the milk yield and growth, including the direct and maternal genetic effects for the latter traits (Table 5). The decomposition of the genetic correlation into direct and maternal effects has not been performed previously. The best comparable one is a study in sheep by Carolino *et al.* (2002) who also estimated the genetic correlation between the milk yield and direct effect for growth. The phenotypic correlations between milk and growth traits were all positive and fairly low. The genetic correlations between the milk yield (both 90-d and total one) and the direct effect of PRW was small and negative (-0.15) while moderate and positive (0.41) with PSW. For the maternal effects of growth traits, the genetic correlation was close to one (0.94) between pre-weaning gain and 90-d milk yield and 0.73 between the same gain trait and total milk yield. For the post-weaning gain, these correlations were zero (-0.02 and 0.04, respectively). Hence most of the maternal genetic variation in early growth traits is explained by variation in doe's genetic potential for milk production. The analysis provided also estimates for the correlation between dam's and animal's permanent environmental effects. They were all small and positive (0.05-0.12) and slightly higher for the early growth.

Correlation between litter size and growth traits

The phenotypic correlations between litter size and birth weight/growth traits were almost zero. The genetic correlations were low. Genetically there are no clear signals that the birth weights would dramatically decrease when litter size is selected for. The genetic correlation of litter size with the direct and maternal effect of BW was positive (0.26 and 0.05). The direct correlation varied from -0.32 to 0.25 and the maternal one from 0.47 to 0.54, while the PSW correlations were close to zero (-0.08 and 0.01). There are no estimates of correlation between litter size and body weight traits of goats in the literature.

There is one study on sheep by Rao and Notter (2000) who also considered maternal effects for growth. Their findings were quite similar to ours. We may conclude like they did that there are no major genetic antagonisms between litter size and growth traits and selection for gain should therefore have little impact on genetic progress for litter size. The estimates for the correlation between dam's and animal's permanent environmental effects were moderately high and positive (0.20-0.44), except the one for PSW, which was zero (0.03).

Computing aspects

Comparing the single, three- and five-trait analyses, most of the estimates are similar. Only the parameters related to birth weight and pre-weaning weight so some discrepancies and therefore remain as interesting cases for further dissecting the computing profiles in the work.

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