GROWTH OF SAANEN, ALPINE AND TOGGENBURG GOATS IN THE FEDERAL DISTRICT, BRAZIL: GENETIC AND ENVIRONMENTAL FACTORS

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ABSTRACT

Data from 1215 kids, with 402 Saanen, 396 Alpine, 200 Toggenburg and 217 ½ Alpine goats, was collected on growth of goats in the Federal District, Brazil from 1995 to 2001. For variance analyses were considered as fixed effect farm, breed, sex, kidding type, month and year of kidding and weight of dam as a covariable. Traits as birth weight and growth from birth to weaning and weaning to first insemination were studied. There was a significant effect of breed, sex and type of kidding on birth weight while weaning weight was only influenced by breed. Month and year of kidding were significant in influencing growth rate after birth. Number of days to insemination weight was influenced by both breed and month of kidding while the insemination weight itself was not influenced by any of the factors studied. Insemination weight was lowly correlated with the other traits in the study, as was to be expected. Days to insemination weight was most highly and negatively correlated with growth rate after weaning and weaning weight showing that faster growing animals that were larger at weaning reached insemination weight more quickly. The correlation between weaning weight and growth rate after weaning was low indicating that animals heavier at weaning did not necessarily grow faster after weaning.

KEY WORDS: Correlation, growth curve, heritability, housed, weight.

RESUMO

CRESCIMENTO DE CABRAS SAANEN, ALPINA E TOGGENBURG NO DISTRITO FEDERAL: FATORES GENÉTICOS E AMBIENTAIS

Coletaram-se dados de 1.215 crias caprinas, sendo 402 Saanen, 396 Pardo Alpina, 200 Toggenburg e 217 ½ Pardo Alpina, entre 1995 e 2001, no Distrito Federal, Brasil. Consideraram-se, como fixos, os efeitos de raça, sexo, número de crias, mês e ano de parto e, como covariável, o peso da cabra, para análise das características peso ao nascer e à desmama, ganho de peso do nascimento à desmama e da desmama à primeira inseminação, bem como idade à primeira inseminação. O peso ao nascer teve relação com a raça, o sexo e o número de crias. Já o peso à desmama, apenas com a raça. O mês e ano de nascimento afetaram o ganho de peso após à desmama. O número de dias para inseminação foi influenciado pela raça e mês de nascimento. As correlações genéticas estimadas entre o peso ao nascer e as demais características evidenciaram-se altas e positivas, exceto em relação ao ganho de peso do nascimento à desmama (0,23). Quanto às correlações obtidas entre o ganho do nascimento à desmama, observaram-se correlações altas e positivas, porém foram altas e negativas no que diz respeito ao número de dias para a inseminação (-1,0). As correlações estimadas entre ganho de peso da desmama à primeira inseminação se apresentaram altas e positivas. Em geral, os resultados indicaram que animais que cresceram mais rápido foram maiores à desmama e às idades posteriores. As herdabilidades estimadas mostraram-se moderadas, indicando que a seleção deve produzir animais com rápido crescimento e que atinjam idade de reprodução com menor idade.

PALAVRAS-CHAVES: Confinamento, correlação, curva de crescimento, herdabilidade, peso.

INTRODUCTION

Goats are an important source of income and subsistence for communities in the Northeast of Brazil, especially low-income populations, as a cheap animal protein. The herds in these regions usually show low productivity and their use in economic farming systems is, as yet, in the early stages. The productivity of goats can be determined by several indices involved in the production system. Growth rate is important as it influences the time required to reach reproductive or slaughter weight and birth weight can have high correlations with weight gain up to weaning (DEVENDRA & BURNS, 1983). Furthermore, there is high potential for growth in this industry and recent figures show that goat milk in Brazil accounted for 0.61% of total milk production (FAO, 2002). Interest in milk production from goats in other regions of the country is growing, but suffers from low level of management practices and technologies adapted for each region.

Production traits are influenced by both genetic and environmental factors such as management practices, climate, nutrition and health, among others (RODRIGUES, 1988). DEVENDRA & BURNS (1983) investigated the factors influencing birth weight of goats in the tropics and observed significant differences between breeds. While the environment may be involved in these differences, MORAND-FEHR (1981) showed that the principal differences were genetic. Naturalised goat breeds in the country are generally adapted to harsh environmental conditions but, in general, show low productivity. Brazilian farmers have, in recent decades, imported genetic material, specialized in milk production, to “improve” their herds. However, selection objectives may vary from country to country (GONÇALVES, 1996), making the estimation of genetic parameters for Brazilian systems a necessity. This work aims to evaluate factors influencing growth in goats from birth to first insemination.

MATERIAL AND METHODS

Data from 1215 kids, with 402 Saanen, 396 Alpine, 200 Toggenburg and 217 ½ Alpine growth goats was collected among 1995 to in the Federal District, Brazil. The animals were kept housed on slatted floors and only female kids were maintained after birth. These received 500 to 600 ml of cow colostrum for the first 6 days of life divided in 5-6 meals per day. After this phase the quantity of milk was gradually increased to 1.5l per day in 2 meals by the 12^{th} day. From this on they were offered a concentrate with minimum of 22% crude protein and hay of alfafa, rami or guandú as well as mineral salt *ad libitum.* Weaning took place at 60 days of age. After weaning the females received elephant grass (*Pennisetum purpureum*, Shum) or corn silage (*Zea mays* L.), depending on the season. They also received approximately 500g/day of concentrate with a minimum 18% crude protein.

At birth the kids were identified and birth date, breed, sex, type of birth (simple/multiple), sire and dam were noted. The animals were weighted every 14 days.

Variance analyses were carried out using SAS (1999) procedure GLM (General Linear Model), with farm, breed, sex, kidding type, month and year of kidding as fixed effects and weight of dam as a covariable. Birth weight (BW) and growth from birth to weaning (GRW) and weaning to first insemination (GRFI), weaning weight (WW), number of days to reach insemination weight (32 kg:days) and actual insemination weight (IW) were analyzed.

The general statistical model was:

$Y_{ijk} = \mu + F_i + C_j + e_{ijk}$, where:

Y_{ijk} = dependent variable (traits);

μ= general mean;

F_i = group of fixed effects;

C_j = covariable ijk;

e_{ijk} = random error associated with each observation.

Heritability, repeatability and (co)variance functions were estimated per breed using MTDFREML (Multiple Trait Derivative Free Restricted Maximum Likelihood (BOLDMAN et al., 1995)):

$Y = X\beta + Z_1a + Z_2pe + Z_3m + e$, where:

Y is a (Nx1) vector of animal observations;

β, is a vector of fixed effects in the model associated with incidence matrix X;

a is a vector of direct genetic effects associated with incidence matrix Z_1;

pe is a vector of permanent maternal environment effects associated with incidence matrix Z_2;

m is a vector of maternal genetic effects associated with incidence matrix Z_3 and

e is a vector of random residuals effects.

RESULTS AND DISCUSSION

The summary of variance analysis is in Table 1. There was a significant effect of breed, sex and type of kidding on birth weight while weaning weight was only influenced by breed. Month and year of kidding were significant in influencing growth rate after birth. Number of days to insemination was influenced by breed and month of kidding while the insemination weight itself was not influenced by any of the factors studied. This was to be expected as the insemination weight was in a small fixed range. There were no significant interactions between farm and breed, therefore these were removed from the model.

TABLE 1. Significance levels for birth weight and growth rates for goats in the Federal District, Brazil

Source of variation	BW	GRW	GRFI	WW	DAYS	IW
Farm	ns	ns	ns	ns	ns	ns
Breed	**	ns	ns	*	**	ns
Month of kidding	ns	**	*	ns	**	ns
Year of kidding	ns	**	ns	ns	ns	ns
Type of kidding	**	ns	ns	ns	ns	ns
Sex of kid	**	-	-	-	-	-
Weight at insemination	ns	ns	ns	ns	ns	ns
Mean	3.42	0.120	0.108	12.14	240.19	32.64
R^2	0.231	0.315	0.247	0.622	0.550	0.268
Cv (%)	18.28	19.24	20.16	17.86	14.17	1.787

*P<0.05; **P<0.01; ***P<0.001; BW – birth weight; GRW – growth rate from birth to weaning and GRFI – growth rate after weaning to insemination; WW – weaning weight, DAYS – days to insemination weight; IW – insemination weight.

On average 240 days were needed for the females to reach a suitable weight for insemination (32.6 kg on average). The means of birth weights were 3.65 ± 0.84 kg for Alpine, 3.38 ± 0.85 kg for Toggenburg, 3.22 ± 0.62 kg Saanen and 3.50 ± 0.39 kg for ½ Alpine (Table 2), showing the superiority of the Alpine kids over the Toggenburg, Saanen and ½ Alpine. Although the Alpine female kids grew faster before weaning, this was not significantly different from the other breeds, as with growth rates after weaning. Weaning weight was significantly higher (P<0.05) for Alpine kids and days to insemination significantly lower (P<0.05) than the other breeds.

The mean birth weights in this study were higher than those found by SANTOS et al. (1989) for Alpine kids (3.12kg). MELLO et al. (1996) also showed lower birth weights for Alpine kids (2.84 kg) while those for Saanen (3.02kg) were similar to those found here (Table 2). SILVA & ARAÚJO (2000) studying crossbred goats in the Northeast of Brazil demonstrated mean birth weights approximately 1kg lighter than those found here, which increased to more than 4 kg at weaning. This may be due not only the genetic potential of the animals in each study but also differences in management and nutritional factors. The effect of breed on birth weight was also found by RODRIGUES (1988) and MAIA (1994) while ACHARYA (1987) and MACEDO *et al*. (1990) did not show significant differences between breeds in different development stages. BOICHARD et al. (1989) in France, verified that adult Saanen females were heavier than Alpine females.

TABLE 2. Birth weight (BW), growth rate to weaning (GRW) and growth rate after weaning (GRFI) for Saanen, Alpine, Toggenburg and ½ Alpine kids in the Federal District, Brazil (ano)

Breed	BW	GRW	GRFI	WW	DAYS	IW
Saanen	3.22	0.119	0.110	11.13	251.82	32.78
Alpine	3.65	0.126	0.108	13.92	217.69	32.66
Toggenburg	3.38	0.112	0.109	11.62	268.82	33.14
½ Alpine	3.50	0.118	0.105	12.17	241.62	32.40

GRW – growth rate from birth to weaning and GRFI – growth rate after weaning to insemination; WW – weaning weight, DAYS – days to insemination weight; IW – insemination weight.

On the other hand, type of birth did not affect (P>0.05) growth rates pre and post weaning (Tab. 1). Nutritional management possibly had an affect as the female kids were distributed in groups depending on their weight and fed to reach insemination weights as quickly as possible. RODRIGUES (1988) found that the difference in weight between animals from simple and twin kidding depended on the availability of milk. Under the conditions here the female kids were fed artificially thereby removing this source of variation.

Month of kidding was a significant source of variation for growth rates before and after weaning as well as days to insemination (Table 1). Preweaning growth rates were higher than postweaning. Kids born at the start of the dry season (March – June) had higher post weaning growth rates than those born at the start of the rainy season, while those born from May to November had higher preweaning growth rates than those born at the other times of the year. This may be due to changes in feeding habits at this time of year, but also may be influenced by environmental temperatures and relative air humidity. No significant differences were found between number of animals born per month, showing a lack of photoperiodism in this region and for this type of system.

Year of kidding effects were only significant for pre-weaning growth rates (Table 1). Some authors (BARBIERI et al., 1990; SILVA & ARAUJO, 2000) attributed this to availability and quality of pasture/ration, as well as nutritional and sanitary management.

Mean weights of animals born as singles were heavier (3.67 kg) than animals born as twins (3.25 kg) and heavier than animals born as triples (2.70 kg). This is in agreement with SOUSA et al. (1990), SILVA et al. (1993, 1994) and GEBRELUL et al. (1994);. On the other hand Mittal (1979), did not find a significant effect of number of kids on birth weights although single kids were heavier than those born in multiple births. This difference is probably due to the intrauterine environment where a higher availability of nutrients to the single kid, lack of competition as well as more space may facilitate growth. Males were significantly heavier than females at birth, 3.53 kg and 3.31 kg, respectively. These results coincide with those found by MEDEIROS et al. (1992), GEBRELUL et al. (1994) and SILVA et al. (1994). On the other hand FIGUEIREDO et al. (1982) and KHAN & SAHNI (1983) did not find differences between the sexes for birth weight in goats. After birth all males were sacrificed and therefore no further information was available on them. Weight at insemination was not significant on the traits in study.

Growth rates in the present study up to weaning (0-60 days) were almost double that found by SILVA & ARAUJO (2000) studying growth rate in crossbred goats from birth to 28 days (0.120 vs 0.064 kg/day respectively) and similar to those from 28 to 56 days (0.118kg/day) but post weaning growth rates were higher than pre-weaning rates. Their data from SILVA & ARAÚJO (2000) included both sexes, but the kids were also reared artificially for a longer time (84 vs 60 days here), which may account for the differences found.

Rapid growth during the pre-weaning period minimizes the cost of rearing and thus provides more profit to the farmer. One way to achieve heavy market weight is to enhance growth performance of the kids, by improving their growth potential and survival rate. This objective can be achieved by selection and by improving environmental conditions. The potential for selection depends largely on the heritability of the trait measured and its correlation with other economical important traits.

Since measurements of body weight are taken at an early age in this species the influence of maternal effects needs to be quantified. Studies on traits measured at an early age in farm animals have shown that both direct and maternal genetic influences are important for animal growth BURFENING & KRESS (1993), TOSH & KEMP (1994), DODENHOFF et al. (1999) and AL-SHOREPY (2001).

Table 3 shows phenotypic and genetic correlations among weight and growth traits measured where correlations are averaged over breeds. Insemination weight had a low phenotypic correlation with the other traits in the study, as was to be expected. Days to insemination weight was most highly and negatively correlated with growth rate after weaning and weaning weight showing that faster growing animals that were larger at weaning reached insemination weight more quickly. The correlation between weaning weight and growth rate after weaning was low indicating that animals heavier at weaning did not necessarily grow faster after weaning. OZOJE (1997) found a negative correlation between growth rates pre and post weaning. This author also found growth rate, frame size traits and body weight to be positively correlated, so that selection for growth rate should result in a reduction in age at marketing and an increase in body weight at maturity.

TABLE 3. Phenotypic, below diagonal, and genetic, above diagonal, correlations between weight and growth traits in goats in Federal District, Brazil

	BW	GRW	GRFI	WW	DAYS
BW		0.23	0.97	0.92	0.87
GRW	0.297		0.93	0.87	-1.00
GRFI	0.223	0.192		0.99	0.88
WW	0.512	0.771	0.190		-0.54
DAYS	-0.345	-0.672	-0.725	-0.747	
IW	-0.007	-0.012	0.274	-0.061	0.052
h^2_d	0.20	0.52	0.38	0.43	0.44
h^2_m	0.12	0.04	0.00	0.01	0.00
c^2	0.35	0.24	0.10	0.06	0.08

GRW – growth rate from birth to weaning and GRFI – growth rate after weaning to insemination; WW – weaning weight, DAYS – days to insemination weight; IW – insemination weight; h^2_d – direct additive heritability; c^2 – permanent environment effects; h^2_m – maternal effect.

AL-SHOREPY et al. (2002) found genetic and phenotypic correlations between traits were positive and of medium to high magnitude for the majority of traits except between birth weight and early growth rate. Genetic correlations between traits were larger than the majority of corresponding phenotypic correlations. The largest relationships were found between chronologically adjacent traits. Estimates of genetic and phenotypic correlations obtained in the present study are considerably higher than corresponding estimates reported by HERMIZ et al. (1997) but fall in the range of estimates reported among growth traits in several breeds of sheep NOTTER & HOUGH (1997) and YAZDI et al. (1997).

The pre-weaning permanent environment effect for birth weight was similar to that found by ZHOU et al. (2002) for Cashmere goats in China. As expected, permanent environment effects after weaning were lower than pre-weaning and birth weight had the highest effects. AL-SHOREPY et al. (2002) found opposing results and related that although the permanent environmental effects had more influence on weaning weight than birth weight, the genetic basis for these effects could not be interpreted. Partitioning maternal effects into additive and permanent environmental components requires a larger amount of data with repeated records on individual dams and the presence of related dams in the data NOTTER & HOUGH (1997). GERSTMAYER (1991) argued that the structure of the maternal design, in terms of number of progeny per dam and the proportion of dams providing their own performance record, influences the accuracy of the estimated parameters. For data sets in which virtually none of the dams had their own record, the accuracy of maternal heritability decreased.

Heritabilities estimates for weight and growth traits varied to moderate to high (0.20-0.52) indicating that selection for these traits should lead to genetic progress if used in breeding schemes (Table 3). These estimates are in agreement with those found in the literature for growth in goats (GEBRELUL et al., 1994; SILVA et al., 1994); OZOJE, 1997; in tropical regions, and higher than those found for goats reared at pasture (MANDONNET et al., 2002). Heritability for age to first insemination was slightly higher than that found for age at first kidding (0.36 using REML) (GONÇALVES et al., 1997). SCHOEMAN et al. (1997) estimated heritabilities for weaning weight of 0.18, with values of 0.04 and 0.07 for m^2 and pe^2, respectively, in the Boer goat. The estimate of direct heritability in this study (0.43) was similar to 0.48 for Common African and Alpine crossbred kids MOURAD & ANOUS (1998), while lower estimates were reported by MALIK et al. (1986) for Bengal goats.

Maternal effects were generally insignificant, especially after birth. AL-SHOREPY et al. (2002) also showed that maternal effects were very small after 30 days of age in goats. The additive maternal value for BW in this study is in accordance with that reported in the Boer goat (SCHOEMAN et al., 1997; YAZDI et al., 1997). In a review of maternal variance component estimates in beef cattle, MEYER (1992) reported an average of 0.17 compared with direct heritability estimate of 0.36. The genetic correlations between direct and maternal influences (r_{gm}) were negative for BW and WW (-0.23 and -0.10), and zero for GRW, in agreement with SCHOEMAN et al. (1997).

CONCLUSIONS

Growth traits in goats reared in confinement in the Federal District in Brazil were affected by environmental factors and these should be considered when selecting breeding seasons. Selection for growth rate should result in a reduction in age at marketing and an increase in body weight at maturity. Alpine goats were shown to be faster growing and reach reproductive maturity faster than the other breeds examined.

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