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Effect of breed and some environmental factors on body weights till weaning and litter size in five goat breeds in Mexico

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ABSTRACT

The aim of this study was to determine the possible effects of breed and some non-genetic factors on weights at birth (BW $n = 17{,}857$), one month of age (MW $n = 14{,}409$), weaning weight (WW $n = 2629$) litter size (LS $n = 17{,}910$) in five breeds of goats in Mexico. Data ($n = 52{,}805$) were collected at the National Goat Center, Tlahualilo, Durango, Mexico from the Nubian (N), Granadina (G), Saanen (S), Toggenburg (T) and Alpine (A) breeds. The model included the fixed effects of breed (BR), gender of kid (GK, 1, 2), type of birth (TB, 1, 2, 3), year of birth (YB, 1–21), season of birth (SB, 1–4) age of dam (AD, 1–10) and their interactions. Overall least square means for BW, MW, WW and LS were 3.03 ± 0.06 kg, 7.17 ± 0.08 kg, 13.2 ± 0.30 kg and 1.67 ± 0.01 kg, respectively. All the traits studied were affected ($p < 0.01$) by breed, year and season of birth and age of dam. The three weights studied were also significantly affected by gender and type of birth. In addition, the phenotypic expression of LS was affected ($p < 0.01$) by BR, YB, SB and AD. In general, neither BW nor MW were related to either AD or SB; LS was negatively correlated ($p < 0.01$) with both BW and WW, irrespective of genotype. The large data set provided estimates with low standard errors. Since genetic change depends not only on genetic estimations but also on the observed phenotypic variation, estimation of non-genetic-environmental factors, must be considered when building statistical models designed for estimation of genetic parameters and genetic evaluation in goats.

1. Introduction

In different goat production systems around the world, the production of early weaned kid (30–40 days of age) allows milking goats for a short-lactation (i.e. 90–120 days); both commodities constitute an important source of income influencing the profitability of the goat industry (Mohammadi et al., 2012; Burren et al., 2013; Escareño et al., 2013). Importing exotic highly productive dairy breeds of goats is an option taken by many stock breeders to increase milk yields. However, besides a high milk

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production, most breeds from temperate latitudes also depict a significant seasonal breeding (Gonzalez-Bulnes et al., 2011). In addition, the kilograms of kids weaned, a parameter highly influenced by doe's fertility and prolificacy, as well as the growth rate of kids also influence in a significant fashion, the profitability of the goat industry (Mellado et al., 2011). This is particularly important when aiming to improve in a sustainable way the productivity of low- and medium-input goat production systems (Escareño et al., 2013; Mandonnet et al., 2013), specially under marginal subtropical as well as arid and semi-arid conditions (Gonzalez-Bulnes et al., 2011). Therefore, when evaluating the success of introducing specialized breeds, comparison of the breeds for these traits under the same environmental and management conditions is of paramount importance. The aim of this study was to determine the possible effects of breed and some non-genetic factors upon the expression of weights at birth, one month of age, weaning weight and litters size in five goat breeds under subtropical, semi-arid conditions.

2. Materials and methods

2.1. Location, environmental conditions, animals and their feeding

Data records considered in this study were obtained from the National Goat Center of Tlahualilo, Durango, located in northern Mexico, at (26° N, 103° W and 1092 m above sea level). Mean annual temperature is 21 °C. The coldest months are December, January and February, with means ranging from 12 °C to 15 °C while the hottest months are from May to September with mean temperatures over 25 °C. Annual rainfall average is 186 mm, with 74% falling between June and October. This climate is classified as warm and extremely dry with rains in summer and fall. The herd was composed of goats produced by crossing, in a recurrent way, local goats of a non-defined breed with imported sires of Nubian, Alpine, Saanen and Toggenburg breeds until reaching a minimum of 31/32 parts of the imported genotype. In most animals (72%) the level of the imported genotype is even higher. The Granadina breed was obtained from mating of local animals similar in appearance to the standard of this breed.

Goats and kids were identified with ear tags and tattoos; regarding newborn kids, the umbilical cord was cut and disinfected at birth and kids had direct access to colostrum from their mother. On day 15 after birth, kids were vaccinated against *Clostridium* and *Pasteurella*, received vitamins A, D and E (i.m.) and were treated against internal and external parasites. Goats were kept under stall-feeding conditions with an uncovered area of 2–10 m^2 per goat. Feeding consisted of green alfalfa, alfalfa hay, sorghum silage, ground sorghum grain and a concentrate mixture containing 14% CP; during the pre-weaning period, all kids had access to alfalfa hay and concentrate. Body weights of kids were registered within 24 h of birth and one month after; subsequently, kids were weaned at an average age of 90 days. All the management and practices were done in accordance with accepted international guidelines.

2.2. Data base management and statistical analyses

Data considered records out of 52,805 production traits collected from 1979 to 2000. Data included information for BW (n = 17,857), MW (n = 14,409), WW (n = 2629) and LS at birth (n = 17,910) from the Granadina, Nubian, Saanen, Toggenburg and Alpine breeds. Data were classified according to genotype (five breeds), gender of kid, type of birth (single, twins, triplets), age of dam at kidding (1–10 years), year of birth (1979–2000) and season of birth [spring (*March*, *April*, *May*), summer (*June*, *July*, *August*), fall (*September*, *October*, *November*) and winter (*December*, *January*, *February*)], in addition to weights, litter size at birth was also recorded. Animals with inconsistent data were deleted to perform final statistical analyses; all the animals were raised under the same management and environmental conditions. The statistical analysis was carried out with a general linear model including the fixed effects of breed, gender, type of birth, year and season of birth, and age of dam and first order interactions. Data editing, descriptive statistics, inferential statistical analyses for fixed effects were performed by using the procedures of the SAS software package (SAS, 2009).

3. Results and discussion

Least squares means and standard errors (LSM ± SE) of the considered productive traits according to various non-genetic factors and levels are shown in Tables 1 and 2. In addition, least-square means for BW, MW and LS for the different levels of first order interactions across genotype are shown in Table 3. All the considered weight traits were affected ($p < 0.01$) by breed, gender, type of birth, year of birth, season of birth and age of doe. Effects of gender, type of birth, and age of doe follow the trend thoroughly reported in this species. Certainly, for all the evaluated growth traits, male kids were constantly heavier ($p < 0.01$) than females. Such trend has been previously reported by Barazandeh et al. (2012) and Moghbeli et al. (2013) in Raini Cashmere goats, nonetheless, averages for BW and WW in either males or females were inferiors to those observed in our study. Gender had major effects on body weight (males > females), adiposity (females > males), leptinemia (females > males) and insulinemia (males > females) through the 90 first days of life (Adam et al., 2013).

Type of birth ($p < 0.01$) affected all growth traits. The negative relationship between BW and TB has been previously reported in goats (Boujenane and El Hazzab, 2008; Jafaroghli et al., 2010; Barazandeh et al., 2012; Moghbeli et al., 2013). Nonetheless, while no differences were observed for MW between twins or triplets, the largest average at WW was observed in triplets, followed from simples and twins. This biological trend denotes a compensatory growth exerted by triplets, suggesting a higher ability from high order litters to increase not only the frequency of suckling but also promoting an increased milk yield; such trend has been previously reported in sows (Auldist et al., 2000). In addition, lambs with low BW caused by intrauterine growth restriction (a similar scenario faced by triplets), had an increased suckling activity, indicative of an increased appetite (De Blasio et al., 2007). Our results differ from that previously reported by Boujenane and El Hazzab (2008), Jafaroghli et al. (2010) and Barazandeh et al. (2012).

Increases in BW and WW occurred as the age of the dam increased up to 6 years, thereafter, a gradual decrease in both BW and WW occurred as goats became older. Such trend agrees with Barazandeh et al. (2012), and Moghbeli et al. (2013). This relationship between BW and dam's age suggests a metabolic conflict between fetal and maternal requirements for body growth in younger dams that did not reach their mature bodyweight (Gonzalez-Bulnes et al., 2011; Meza-Herrera and Tena-Sempere, 2012). All the evaluated growth traits, BW, MW and WW, were affected by year of birth. The last agrees with reports in Draa goats (Boujenane and El Hazzab, 2008) in Boer goats (Mohammadi et al., 2012) and in Raini Cashmere goats (Barazandeh et al., 2012; Moghbeli et al., 2013).

Regarding breed differences for growth traits, the largest BW, MW and WW were depicted ($p < 0.01$) by Saanen and Alpine. The observed growth traits in our study