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Breed genotype effect on ewe traits during the pre-weaning period in hair sheep under the tropical Mexican conditions

M.M. Nasrat[a,b,*], J.C. Segura Correa[a], J.G. Magaña Monforte[a]

[a] Facultad de Medicina Veterinaria y Zootecnia, Universidad Autónoma de Yucatán, Mérida, Yucatán, Mexico
[b] Department of Animal Production, Faculty of Agriculture, Assiut University, Assiut, Egypt

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ABSTRACT

The present study was carried out on a commercial farm in southwest of Mexico to determine breed group effects of hair sheep (Pelibuey, Dorper, Katahdin, and Blackbelly and their crosses) and their genetic components (breed additive, breed maternal and heterosis effects on litter weight at birth, adjusted litter weaning weight at 60 days, and lambing interval. The dataset included records from 1821 four-purebred ewes and crossbreed groups (representing 9 different crosses between the four pure breeds). In total, there were 6371 lambing events from 2007 to 2013. The first model included the effects of breed, parity, litter size, season of lambing, year of lambing and season × year interaction. Those significant effect ($P < 0.05$) were included in the models to estimate the breed additive, breed maternal and heterosis effects. Breed additive and breed maternal effects were expressed as deviations from the Pelibuey breed. Breed, parity and litter size were significant sources of variation for all the traits ($P < 0.05$), but season and year interaction were significant only for litter birth and weaning weight ($P < 0.05$). Heterosis effect was only observed for adjusted litter weaning weight at 60 days of age for the Pelibuey × Katahdin crossbred ewes ($P < 0.05$). Under the conditions of this study, direct heterosis and maternal effects between the four breeds studied has shown no significant effect on these traits. Non-genetic factors had a greater influence on the traits studied than the genetic makeup of the ewe.

1. Introduction

Lamb production is an important source of income for farmers around the tropics in Mexico, and sheep population has had a substantial growth during the last decade. The Mexican sheep inventory increased from 6 million in 1996 to 8.5 million in 2013 (SIAP SAGARPA, 2013). Sheep production has extended to the Mexican tropical regions (Góngora-Pérez et al., 2010) mainly due to the high adaptability of hair sheep breed to its climatic conditions (de Lucas and Arbiza, 2006).

It was postulated that effort for production improvement should be directed to the ewe, as one of the main factors for economic profitability is to increase performance during the pre-weaning period. Important economic traits such as litter birth weight, adjusted litter weaning weight at 60 days and lambing interval are used as indicators of ewe productivity. Accurate estimates of genetic components for economically important traits, such as additive direct and maternal effects as well as maternal heterosis effects are fundamentals for efficient designing of breeding program (Dillard et al., 1980) as it facilitates the complete usage of genetic differences among breeds by breeders to improve their crossbreeding schemes. In order to characterize and predict the performance of breed crosses, estimation of genetic effects in terms of breed additive, breed maternal, individual heterosis, and maternal heterosis have been done in cattle (Alenda et al., 1980; Dillard et al., 1980; Robison et al., 1981; Schoeman et al., 1993; Magaña and Segura, 2003; Osorio-Arce and Segura 2010). However, to our knowledge, there are no studies of this type in hair sheep under the Mexican tropical conditions.

The objectives of this study were to (1) to obtain estimates of differences among ewes from four hair sheep breeds and their reciprocal crossbreds for litter weight at birth, adjusted litter weaning weight at 60 days, and lamb interval; and (2) to determine the contributions of breed additive, heterosis and maternal effects to differences among the previously mentioned pre-weaning traits.

* Corresponding author.
E-mail addresses: mahmoud.abdelati@gmail.com, mmnasrat@gmail.com (M.M. Nasrat).

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2. Materials and methods

2.1. Dataset

The data were retrospectively obtained from the historical records from a commercial farm located 5 km from the municipality of Muna, Merida, Yucatan, in Mexico. Thus, the authors had no input in the animal husbandry practiced at the farm. The dataset includes records from 1821 four-purebred ewes (Pelibuey, Dorper, Katahdin and Blackbelly) and 35 crossbreed ewes (representing 9 different cross groups). In total, there were 6371 lambing events from 2007 to 2013. Data recorded include litter size, parity number, birth weight, weaning weight, age at weaning and lambing interval.

2.2. Animal husbandry

The farm had a total area of 380 ha of which ninety-two hectares were used for sheep production. From those, 66 ha (divided in 55 lots of approximately 1.2 ha each) were permanently used and had an established irrigation system. Twenty-two hectares (divided in 22 lots of 1 ha each) were only use temporarily. Sheep grazed for 2 days in each lot. The farm had four pure hair sheep breeds—Katahdin, Pelibuey, Blackbelly- and Dorper as well as their different crosses. Controlled natural mating (i.e. selection of candidates to produce the next generation) was used only for Katahdin and Pelibuey ewes to produce purebred Katahdin and purebred Pelibuey ewes and rams (i.e. Katahdin ewes only mated with Katahdin rams and Pelibuey ewes only mated with Pelibuey rams) and to produce Katahdin × Pelibuey or Pelibuey × Katahdin ewes. Uncontrolled natural mating (i.e. ewes of any of the breeds present at the farm can mate with any of the other breeds) was used for crossbred females to produce terminal animals

Replacement ewe lambs were pre-selected at weaning (approximately 60 days of age) using a visual scoring and final selection was done at approximately 120 days of age. Irrespectively of their breed, replacement ewe lambs entered the breeding herd at 9 months of age and they were housed in a mating batch with older ewes and all received the same husbandry practices. After 65 days of transfer to the mating batch, pregnancy was checked and once pregnancy was confirmed, ewes were transferred to a gestation flock. Non-pregnant ewes were remained in the lock for another oestrus cycle and subsequently if pregnancy was not confirmed, they were culled due to reproductive failure. The gestation batch was visually inspected every 2 weeks to identify ewes which due date was soon and once identified, they were transferred to the lambing pens. Ewes received no assistance during lambing, and lambing pens were checked daily to record lambing ewes and to register the lamb into the farm database. Additionally, this practice helped to identify ewes that were not nursing their lambs. In such case, lambs were transferred to individual crates where they were manually fed. One week after lambing, ewes and their lambs were moved to the lactation pens where they remained until weaning (approximately 60 days post lambing). At weaning, ewes were moved back to the mating lots unless their body condition score was considered poor (i.e. score of 2 or lower on a scale from 1 to 5). There was no specific feeding strategy for ewe lambs as they were pre-selected as dams at 120 days of age; however, the amount of concentrate (grain) feed offered to the ewe lambs was slowly decreased and the amount of time grazing and the amount of cut Taiwan grass (*Pennisetum* sp.) offered was increased. Feeding in the mating and gestation flock consisted mainly on grazing and the provision of minerals. Ewes close to lambing and lactating ewes received 400 g of a commercial concentrate feed. Additionally, from transfer to the lambing pen up to 4 weeks of lactation, ewes received cut Taiwan grass. From week 5 of lactation until weaning off lambs, ewes had restricted access to grazing from 8:00 am to 12:00 pm on a daily basis. From birth until 4 weeks of age, lambs were with their dams to nurse as well as ad libitum access to a commercial pre-started diet, which was located in a restricted space where only lambs could access all the day. Once the lambs were 28 days of age until weaning, lambs were allowed to nurse during two periods per day, one in the morning from 6:00 to 8:00 am; and in the afternoons from 2:00 to 4:00 pm while continued to have ad libitum access to the commercial pre-started diet were practiced every day. Vaccination against Clostridios and Pausteurella and deworming were done every 6 months. For deworming, Ivermectin and Closantel sodium were used.

2.3. Statistical analysis

2.3.1. Model 1

Data were tested for normality using the Shapiro-Wilk tests and examination of the normal plot. Litter birth and weaning weight and lambing interval were analyzed using mixed model procedures (PROC MIXED of SAS v9.3; SAS Inst. Inc., Cary, NC) to obtain least square means for each level of the main factors and to determine the significant fixed effects to be included in model 2. Months of the year were classified into three seasons due to the climatic characteristics of the farm location as follow: dry = February–May (average monthly temperature = 22.8–28.0 °C; rainfall = 26.7–105.3 mm/month; wind = 19.8–19.4 km/h); rainy = June–October (average monthly temperature = 27.7–25.2 °C; rainfall = 169.4–128.4 mm/month; wind = 18.7–18.4 km/h); and, windy and rainy = November–January (average monthly temperature = 23.2–21.2 °C; rainfall = 60.5–30.3 mm/month; wind = 21.9–23.8 km/h). Parity ranged from parity 1 to 10; however, because of few ewes with parity ≥ 8 (parity 8 = 99 ewes, parity 9 = 33 ewes and parity 10 = 10 ewes) they were re-classified into single category parity 8^+.

Adjusted litter weaning weight at 60 days of age was calculated the using the following formula proposed by Schoenian (2014):

$$Adjusted\ \ litter\ weaning\ weight = Birth\ \ weight\,(kg) + ((ADG, kg) \times 60 days)$$

where:

$$ADG = \frac{(Weaning\ \ litter\ weight,\ kg - litter\ \ birth\ weight,\ \ kg)}{Weaning\ \ age}$$

Due to the low number of crossbreds dams in each of the breed groups, crossbred were re-classified into a single group “crossbreds”. Initial models included dam’s breed, parity, season, year, the interaction between season × year and litter size as fixed effects. For all the models used, there were three levels for season (i.e.dry, rainy and windy); five levels for breed (Katahdin, Dorper, Blackbelly, Pelibuey and the crossbred ewes); eight levels for parity (parities 1–7 and parities ≥8), six levels for year (from 2008 to 2013) and three levels for litter size (single, twins and triplets). A backward elimination of fixed effects was used to select the predictor variables that would remain in the final model. The backward elimination of fixed effects technique begins by calculating ***F*** statistics for a model, which includes all of the independent variables. Then the variables are deleted from the model one by one until all the variables remaining in the model produce ***F*** statistics significant at a preset *P* value specified in the model At each step, the variable showing the smallest contribution to the model is deleted. In the present study, only fixed effects with a $P < 0.10$ remained in the final model except for dam’s breed, which was included in the model irrespective of its *P* value. Final models for litter birth and weaning weight included breed, parity, season × year interaction and litter size. The final model for lambing interval included breed, parity and year. Statistical differences were reported when model source of