



Non-genetic effects on preweaning growth traits in Colombian Creole hair sheep

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ABSTRACT

Objective. Determine the effect of some variation factors that affect the characteristics of birth weight (BW), adjusted weaning weight (AWW) at 90 days and pre-weaning weight gain (PWW) in Colombian hair sheep. **Materials and methods.** 525 data from Colombian hair sheep (OPC) offspring, reared in an extensive production system under conditions of the lower Colombian tropics were used. A linear fixed effects model (GLM) was used, which included the sex of the calf, the type of calving (single or multiple), the calving number of the ewe (primiparous or multiparous), the climatic season of birth (dry or rainy) and the year of birth (2017 to 2020) and their interactions. The analyzes were carried out with the statistical package SAS University® 2021. **Results.** The BW, AWW and PWW values were 2.9 ± 0.1 kg, 13.2 ± 1.6 kg and 0.15 ± 0.064 kg, respectively. The BW was significantly affected ($p < 0.05$) by all the factors studied. So then, the males, the offspring of simple delivery, of first-time ewes, in the rainy weather season and in 2019 had better performance. The AWW only varied significantly due to the effects of calving number, the climatic season and the year. Finally, the PWW was only affected by the rainy weather season and by the year. **Conclusions.** The BW turned out to be the variable most sensitive to the factors analyzed. In maternal effects, the type of delivery did not affect the AWW and PWW, while the number of deliveries affected the AWW but not the PWW.

Keywords: Pre-weaning growth; pre-weaning weight gain; birth weight; adjusted weight at weaning (*Source: CAB*).

RESUMEN

Objetivo. Determinar el efecto de algunos factores de variación sobre las características peso al nacimiento (PN), peso al destete ajustado (PDA) a los 90 días y la ganancia de peso predestete (GPP) en ovinos de pelo colombiano (OPC). **Materiales y métodos.** Se utilizaron 525 datos de crías de OPC, manejados en un sistema extensivo de producción, en condiciones del trópico bajo colombiano. Fue utilizado un modelo lineal de efectos fijos, que incluyó, el sexo de la cría, el tipo de parto (sencillo o múltiple), el número de parto de la oveja (primípara o múltipara), la época climática de nacimiento (seca o lluviosa) y el año de nacimiento (2017 al 2020) y sus interacciones. Los análisis se realizaron con el paquete estadístico SAS University® 2021. **Resultados.** Los valores de PN, PDA y GPP fueron 2.9 ± 0.1 kg, 13.2 ± 1.6 kg y 0.15 ± 0.064 kg, respectivamente. El PN

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fue afectado significativamente ($p < 0.05$) por todos los factores estudiados. Las crías macho, las de parto simple, las de parto primerizo, las nacidas en época lluviosa y en particular las nacidas en el año 2019, tuvieron mejor desempeño. El PDA, solo varió significativamente por los efectos número de parto, época climática y año. La GPP solo se afectó por la época lluviosa y por el año. **Conclusiones.** El PN resultó ser la variable más sensible a los factores analizados. El tipo de parto no afectó el PDA y la GPP. El número de parto afectó al PDA pero no al GPP.

Palabras clave: Crecimiento predestete; ganancia de peso predestete; peso al nacimiento; peso ajustado al destete (*Fuente: CAB*).

INTRODUCCIÓN

Several authors suggest that the Colombian hair sheep (OPC) is a suitable breed type for meat production under extensive production systems (1,2,3), thanks to its adaptation to the environmental conditions of the tropics, such as tolerance to high temperatures, high parasitosis and its capacity to feed from pastures of low nutritional value (4). Even so, the implementation of technology in the productive system has been gradual, the transfer of techniques and knowledge in areas such as reproduction, nutrition, health and genetic improvement comes from subtropical countries (1,4), and this could become an impediment for the competitiveness of the sector (5).

This makes it necessary to generate new knowledge to strengthen the basis for the implementation of genetic improvement programs, programs that are currently scarce in the OPC, or based on crossbreeding with foreign breeds, taking advantage of heterosis and hybrid vigor (6) on productive characteristics related to lamb growth, conformation and finishing, but leaving aside relevant related characteristics, such as fertility, prolificacy, maternal behavior, milk production and lamb survival (6).

Together, the above characteristics are known as maternal ability (7), and although they can be measured directly in ewes, some characteristics are indirect indicators of this ability, such as birth and weaning weights of the lamb. Generating information related to lamb birth weights, weaning weights and weight gain per day during lactation is essential for the initiation of selection and genetic improvement plans (3). Having said this, the objective of this research was to determine the effect of some variation factors that affect birth weight (BW), adjusted weaning weight (AWW) and preweaning weight gain (PWG) in Colombian hair sheep.

MATERIALS AND METHODS

Location. This work was carried out on the premises of the San José farm, located in the municipality of Palmito Sucre, at an altitude of 3.0 masl. The life zone of the study site is classified as tropical dry forest (bs-t), with an annual rainfall of 1585.8 mm, an average annual temperature of 30°C and relative humidity of 80% (8).

Animal management. The females were kept in mating flocks for 45 days at a 1:25 ratio (male: female). Once the pregnancy of the female was confirmed by transrectal ultrasound, the pregnant ewes were kept under continuous grazing conditions, in *Bothriochloa pertusa* and *Braquiaria brizanta* pastures, with water and salt ad libitum. The lambing was attended by a trained operator. After calving, the calves and mothers were kept in pens and paddocks separated from non-lactating females and growing animals. During the first week of lactation, the mothers received a commercial balanced feed (17% protein) at a rate of 350 g/day in two portions and corn silage only during the dry season. The ewes were weaned at 90 days of age, and the ewes were returned to gestation management and the offspring to growth flocks.

During gestation the ewes were regularly evaluated by the FAMACHA method and selective deworming was performed, as appropriate. One month before lambing, pregnant ewes were vaccinated against pasteurellosis and clostridiosis. On the other hand, lambs only received vaccines against these same pathogens 15 days before weaning (9).

Data analysis. Were used 525 offspring data from Colombian Creole hair sheep (OPC), corresponding to births occurring between the years 2017-., corresponding to births occurring between the years 2017-2020. The sample

size was by convenience by including all the available data of the offspring that were in the records at the farm at the time of the study (1,2). The variables analyzed were lamb birth weight (BW), lamb adjusted weaning weight (AWW) (1) and preweaning weight gain (PWG).

To distinguish the significance of the factors on the studied variables, a linear fixed effects model (GLM) was used, which included, sex of the offspring at birth, type of lambing (single or multiple), lamb lambing number (primiparous or multiparous), climatic time of birth (dry or rainy) and year of birth (2017 to 2020) and their interactions. The number of lambing of the ewe was considered as a covariate within the model. In cases where significant differences ($p < 0.05$) were found, the Tukey -Kramer test was used. The statistical package SAS University, 2021® was used for the analyses. The statistical model used was:

$$Y_{ijk rz} = \beta_0 + \beta_1 X_{ijk rz} + P_j + M_k + E_r + S_z + (P^*M)_{jk} + (P^*E)_{jr} + (P^*S)_{jz} + (M^*E)_{kr} + (M^*S)_{kz} + \varepsilon_{ijk rz}$$

Where:

$Y_{ijk rz}$: Dependent variables. Weight of lambs at birth, adjusted weaning and pre-weaning weight gain, for the i-th individual, of the j-th sex, of the k-th type of lambing, in the r-th climatic season of the year of birth or weaning, in the z-th year of birth or weaning.

β_0 : Intercept

β_1 : Regression coefficient

$X_{ijk rz}$: Number of births of the mother (Primiparous Vs Multiparous)

P_j : Effect of the j-th sex of the animal (female vs. male)

M_k : Effect of the k-th type of deliveries (single vs. multiple)

E_r : Effect of the r-th climatic season of the year of birth or weaning (dry vs. rainy).

S_z : Effect of z-th year of birth or weaning (2017-2020).

$(P^*M)_{jk}$: Effect of the interaction of sex j with type of delivery k

$(P^*E)_{jr}$: Interaction effect of sex j with season of year of birth or weaning r

$(P^*S)_{jz}$: Effect of the interaction of sex j with year of birth or weaning z

$(M^*E)_{kr}$: Effect of the interaction of type of births k season of year of birth or weaning r

$(M^*S)_{kz}$: Interaction effect of type of births k with year of birth or weaning z

$\varepsilon_{ijk rz}$: Random effect of the error associated with each observation.

RESULTS

Table 1 shows the descriptive statistics for the variables BW, AWW and PWW. Birth weights ranged from 2.1 kg to 3.6 kg, this range made this variable have the highest coefficient of variation. Adjusted weaning weight was 13.2 ± 1.6 kg. While, on average, lambs gained 150 g/day, this variable varied the least statistically.

Table 1. Statistical descriptors for BW, AWW and PWW characteristics in OPC lambs.

Ítem	BW	AWW	PWW
Mean (kg)	2.9	13.2	0.15
SD (kg)	0.1	1.6	0.064
CV (%)	18.2	13.4	11.7
Minimum (kg)	2.1	9.2	0.125
Maximum (kg)	3.6	16.3	0.286

SD: Standard deviation, CV: coefficient of variation.

The birth weight was significantly affected ($p < 0.05$) by all the variation factors studied, thus, the highest values were found in males, in single lambing lambs, in primiparous ewe births, in dry climatic season births and for the year 2019 (Table 2). AWW was not affected by sex of the offspring nor by type of lambing (Single vs. Multiple). Then, the highest weaning weights were obtained in the rainy climatic season ($p < 0.05$) and in the years 2019 and 2020 ($p < 0.05$). Finally, sex of the offspring, type of lambing and lambing number of the ewe did not significantly affect preweaning weight gain (Table 2). Still, in the dry climatic lambing season and in the years 2018, 2019 and 2020, the best PWW values were obtained ($p < 0.05$).

The interaction between lamb sex and the other factors was not significant for BW, AWW and PWW. In contrast, the interaction between lambing type and climatic season affected BW and PWW. And the interaction between lambing type and year of lambing affected all dependent variables (Table 2).

Table 2. Least squares means (\pm standard error) of BW, AWW and PWW, according to the factors sex, type of parturition, maternal parturition number, climatic time of parturition, year of birth and their interactions in OPC lambs.

Variation factor	N	BW (kg)	AWW (kg)	PWW (kg)
Sexy				
Females	271	2.7 \pm 0.3 ^a	13.6 \pm 0.4 ^a	0.121 \pm 0.1 ^a
Males	254	3.3 \pm 0.4 ^b	14.1 \pm 0.11 ^a	0.135 \pm 0.3 ^a
Type of delivery				
Simples	352	3.2 \pm 0.3 ^a	13.2 \pm 0.2 ^a	0.132 \pm 0.1 ^a
Multiples	173	2.7 \pm 0.1 ^b	12.3 \pm 0.1 ^a	0.123 \pm 0.1 ^a
Mother's delivery number				
Primiparous	156	2.9 \pm 0.16 ^a	13.3 \pm 0.20 ^a	0.129 \pm 0.1 ^a
Multiparous	369	2.6 \pm 0.23 ^b	11.5 \pm 0.21 ^b	0.122 \pm 0.6 ^a
Climatic time of calving				
Dry	210	3.1 \pm 0.3 ^a	12 \pm 0.2 ^a	0.114 \pm 0.02 ^a
Rainy	315	2.8 \pm 0.2 ^b	14 \pm 0.3 ^b	0.118 \pm 0.01 ^b
Year of birth				
2017	102	2.9 \pm 0.04 ^a	11 \pm 0.5 ^a	0.121 \pm 0.2 ^a
2018	89	2.8 \pm 0.05 ^a	12 \pm 0.20 ^a	0.129 \pm 0.6 ^b
2019	160	3.0 \pm 0.02 ^b	13 \pm 0.3 ^b	0.132 \pm 0.8 ^b
2020	174	2.8 \pm 0.01 ^a	14 \pm 0.2 ^b	0.131 \pm 0.7 ^b
p- Interaction				
(P*M)jk		0.23	0.52	0.15
(P*E)jr		0.54	0.26	0.74
(P*S)jz		0.17	0.39	0.18
(M*E)kr		0.002	0.052	0.06
(M*S)kz		0.012	0.003	0.04

n= Number of data;

(P*M)jk = Effect of the interaction of sex j with type of delivery k, for year of birth, weaning or mean daily weight gain.

(P*E)jr = Effect of interaction of sex j with season of year of birth, weaning or mean daily weight gain r;

(P*S)jz = Effect of the interaction of sex j with year of birth or weaning z;

(M*E)kr = Effect of the interaction of calving type k season of year of birth, weaning or mean daily weight gain r;

(M*S)kz = Effect of interaction of calving type k with year of birth, weaning or mean daily weight gain z.

DISCUSSION

The present study characterized some non-genetic factors affecting preweaning growth in OPC lambs in extensive production systems under low tropical agroclimatic conditions.

The birth weight (BW) found here was slightly higher than that reported by Montes-Vergara et al (1) and by Vergara et al (9) in sheep of the same breed, and that reported in Pelibuey lambs from the humid tropics of Mexico (10). But lower than that found in OPC lambs crossed with Pelibuey (3.02 \pm 0.66 kg) (11). On the contrary, in crosses of wool sheep (Romney Marsh, Ile de France and Moro Colombiano) from the Colombian high tropics (2562 masl), the BW was higher (3.66 \pm 0.20 Kg) than this report (12).

The BW of the lambs was significantly affected ($p < 0.05$) by all the variables studied. Like other authors, sexual dimorphism was evidenced in the BW (1,11), this may be related to a higher rate of bone growth during gestation in males (13,14), being related to the activation of the *sry* gene (androgens and antimullerian hormone) in the Y chromosome (15). Non significant effects were reported in Pelibuey lambs in Mexico, by Hinojosa-Cuéllar et al (10), Vergara et al (9) in OPC lambers in Córdoba (Colombia) and in wool type biotypes in Colombia (12).

Likewise, females with single births had lambs of higher birth weight, this is congruent with other studies in this (1,13) and other related breeds (10,11). This is explained by the absence of competition for nutrients and uterine space that normally occurs in multiple gestations (2).

The highest BW was found in the rainy season. Similar results were found in mongrel sheep OPC by Pelibuey (11) and contrary results were presented in Pelibuey lambs (10), the differences may be related to climatic and/or management factors of the production systems.

The adjusted weaning weight (WAP) was higher than that reported for this same breed group by Montes-Vergara et al (1) and by Vergara et al (9) with an adjusted weaning age of 90 days. It was also higher than that reported by Hinojosa-Cuéllar et al. (10) in Pelibuey lambs weaned at 60.3 \pm 8.6 days. But lower than that presented by Lenis et al (11) in crossbred OPC sheep (19.0 \pm 3.7 kg), however, these lambs were weaned at 120 days of age. A higher AWW

value (14.88 ± 0.67 kg), is presented in lambs of wool biotype in the Cundiboyacense highlands of Colombia (12).

Like other reports, AWW was not affected by lamb sex and type of lambing (1, 10). However, the results of Lenis et al (11) in crossbred OPC sheep show significantly higher weaning weights in males and single lambing lambs. The higher BW in OPC males is also reported by Vergara et al. (9).

Even so, the AWW varied according to the number of lambing of the ewe, as presented by other authors in this same racial group (1). Some authors suggest that, with increasing age, the reproductive performance of the female improves (16), a phenomenon attributed to the weight of the ewe at mating (17), because along with growth also comes an increase in body development and physiological state that makes her more efficient in the expression of maternal ability, producing more milk and weaning heavier animals (18).

This is contrary to our findings and those reported by Montes-Vergara et al (1). Our results indicate a better performance in primiparous females. In addition, in extensive sheep production systems in tropical conditions, nulliparous ewes are mated at low body weights (20-26 kg), which would aggravate the situation (18,19). Thus, one reason that could explain this result would be the coincidence between lambing and lactation of primiparous ewes with the rainy climatic season, when there is a greater forage supply.

The results obtained show that lambs weaned during the rainy season have a better weight. On the other hand, Lenis et al (11) show better results in lambs weaned in the dry season. While, in Pelibuey lambs, values of 11.6 ± 0.1 , 9.9 ± 0.2 and 12.2 ± 0.3 are presented for the dry, rainy and northerly seasons, respectively, with statistical differences among all ($p < 0.01$) (10). These variations can be explained by the duration of lactation in each study, which varied from 60 to 120 days, and by the sample sizes.

The preweaning daily weight gain (PPG) found in this study was considerably higher than that reported by Rúa-Bustamante et al. (2) in three different farms. They found PWW between 105 and 114 g/day, with no difference between farms, which was explained by the high racial similarity and the agro-climatic and

management conditions in the three production systems. Likewise, our report is higher than that presented by Montes-Vergara et al (1) in PPOs with similar agro-climatic conditions. It is also higher than that reported by Vergara et al (9) in OPC lambs from the department of Córdoba (Colombia) with PWW of 95 ± 0.04 g/day. Similarly to that found in Pelibuey lambs from Mexico with 60 days of lactation (10) and to that presented by Lenis et al (11) in mestizo lambs OPC by Pelibuey. These authors also point out that these weight gains are excellent for extensive production systems. Likewise, the values obtained are consistent with production systems with a medium technological level (19). In comparison with lambs of wool biotype (12), the PWW of the OPC of this study was lower (150 ± 17.55 g/day vs. 133.45 ± 7.7 g/day).

The results obtained showed that there was no effect of lamb sex on PWW, which is in agreement with that presented in another study for the same breed (1) and for Pelibuey lambs (10). The behavior of this variable may be related to other factors that were not studied here, such as pre-lambing feeding, body condition, health status and colostrum and milk production capacity. However, other studies report higher PWW in females (115 ± 0.51 g/d) than in males (103 ± 0.49 g/d) with statistical differences between values ($p < 0.01$) (2). While, other authors present the opposite (9) in OPC lambs, with PWW of 0.11 ± 0.005 in males and 0.09 ± 0.006 in females.

The type of calving of the female (single vs. multiple) did not significantly affect the PWW, although, females that gave birth to a single calf presented a better value. The results of Montes-Vergara et al. (1) are similar to our report. Rúa-Bustamante et al (2) showed that lambs from single births had 10.5% and 15.4% more PWW ($p < 0.01$) than lambs from double and triple births, respectively. Similar behavior is presented for PWW in Pelibuey lambs (10).

The PWW was significantly affected by the effect of climatic season. In the rainy season, the higher forage supply is the reason that explains this result. Similar findings are presented in OPC lambs by Montes-Vergara et al (1) and by Hinojosa-Cuéllar et al. (10) in Pelibuey lambs. Likewise, year affected PWW ($p < 0.05$), with a tendency to increase over time, this could be related to improvements in the management practices of the production system.

Although this study did not evaluate the interaction between the sex of the calf and the type of birth on PWW, other authors indicate that there are no differences between sexes in single births, but in double births the females have better PWW and in triple births it is the males that stand out in PWW (2).

In conclusion, in extensive production systems in the Colombian low tropics, the preweaning growth characteristics BW, AWW and PWW in OPC lambs were significantly affected by the sex of the lamb at birth, the type and number of births of the ewe, the climatic season and

the year. BW was affected by all the factors analyzed, presenting better performance in males, in single lambing offspring, from lambing of first-time females, in rainy climatic season and in the year 2019. Likewise, primiparous females, the performances of the rainy climatic season and the year 2020 were the best for the AWW trait. Finally, PWW was only affected by the rainy climatic season and by year.

Conflict of interest

The authors declare no conflict of interest.

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