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Sheep´s lamb behavior fed with fresh orange peel with different supplementation level

Comportamiento de corderos de ovejas alimentadas con cáscara fresca de naranja y niveles de suplementación

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ABSTRACT

The objective was to assess the productive performance of hair sheep fed with fresh orange peel through gain weight from birth until weaning on three hair sheep breeds. The experiment was conducted at the Zootechnic post of the Engineering and Science Faculty in Güemez, Tamaulipas, Mexico. 74 Blackbelly sheep (n = 19), Katahdin (n = 24) and Pelibuey (n = 31) were placed randomly in three pens and three levels of supplementation (300, 450 and 600 g per animal^{-1} day^{-1}). The lambs' weight was registered at birth and at 60 days of age, as well as the daily weight gain pre-weaning. None of the variables were affected (P > 0.05) by the genotype and supplementation level or by the genotype interaction with the supplement, except the weight at weaning by the type of delivery (P < 0.05). The average birth weight, weaning weight and daily weight gain pre-weaning were 2.50 ± 0.15, 9.25 ± 1.57 and 0.11 ± 0.01 kg respectively. It is concluded that the genotype and the supplementation level did not affect the productive performance of the lambs of hair breeds.

Key words: birth weight, weaning weight, supplementation, breeds of hair.

RESUMEN

El objetivo fue evaluar el comportamiento productivo de ovejas alimentadas con cáscara fresca de naranja a través de la ganancia de peso de sus corderos de tres razas de pelo desde el nacimiento hasta el destete. El experimento se realizó en la Posta Zootécnica de la Facultad de Ingeniería y Ciencias en Güemez, Tamaulipas, México. Se colocaron aleatoriamente 74 ovejas Blackbelly (n = 19), Katahdin (n = 24) y Pelibuey (n = 31) en tres corrales y tres niveles de suplementación (300, 450 y 600 g animal^{-1} día^{-1}). Se registró el peso de los corderos al nacimiento y a los 60 días de edad, así como la ganancia diaria de peso pre-destete. Ninguna de las variables fueron afectadas (P > 0.05) por el genotipo y nivel de suplementación o la interacción de genotipo x suplemento, excepto el peso al destete por tipo de parto (P < 0.05). Las medias generales de peso al nacimiento, peso al destete y ganancia diaria de peso pre-destete fueron 2.50 ± 0.15, 9.25 ± 1.57 y 0.11 ± 0.01 kg, respectivamente. Se concluye que el genotipo y nivel de suplementación no afectó el comportamiento productivo de los corderos de razas de pelo.

Palabras clave: Peso nacimiento, peso destete, suplementación, razas de pelo.

INTRODUCTION

In tropical zones, the sheep production system is based mainly on grazing (Duarte and Pelcastre, 2000), where grazing does not maintain quantity and quality throughout the year, which makes it difficult to supply nutrients to animals during all seasons of the year, and the low nutritional quality thereof cause a decrease in the consumption of voluntary food (Clavero, 2013).

According to Faustino-Lázaro *et al*. (2016), these conditions affect the growth of young animals, and the reproductive capacity of adults is reflected in a decrease in their productivity, reduction in the growth rate, fewer lambs per birth, small size of calves at birth and at weaning

A strategy of feeding in critical physiological stages and highly demanding of nutrients such as breastfeeding and mating (León *et al*., 2003), is crucial in times of high environmental stress.

The use in animal feed of agroindustrial and livestock by-products is an alternative to increase the productive and economic efficiency of animal production units (Villanueva *et al*., 2013; López-Herrera *et al*., 2014; Martínez-González *et al*., 2016).

In Tamaulipas, Mexico, approximately 605 thousand tons of orange, lemon and grapefruit are produced, of which 10% is destined for the juicing industry, while the rest is consumed as table fruit. During this process, a large amount of by-product is obtained, generating a residue of 45 to 60% of the weight of the fruit, which is composed of 60 to 65% of peel, 30 to 35% of pulp and 0 to 10% of seeds; these residues constitute the fresh citrus peel (CFC) which can be used in animal feed (Bampidis and Robinson, 2006, Martín, 2009, Villanueva *et al*., 2013).

By-products derived from the citrus industry that are of regular nutritional value, can be used in varying amounts in rations for sheep, since it has a high energy value, with a content of total digestible nutrients of approximately 80%, with protein, carbohydrates and highly digestible neutral detergent fiber (González *et al*., 2013; Villanueva *et al*., 2013).

However, the protein content of CFC is limited, so it is necessary to provide nitrogen from other sources when it is used to balance a ration, so in some regions CFC is an agro-industrial byproduct that can help reduce the fattening time and the mortality of the grazing lamb.

Results of several studies (Lucero *et al*., 2011) in regions of the Mexican tropics, mention that the weight at birth (PN) is in the range of 1.78 to 2.74 kg, while the weights at weaning (PD) go from 9.50 to 11.40 kg.

Therefore, the objective of the present study was to evaluate the behavior of sheep fed fresh orange peel (CFN) and different levels of concentrate supplementation, through the

productive behavior of their lambs of different genotypes, from birth to weaning in the northeast of Mexico.

MATERIALS AND METHODS

Location of the experimental site: the present experiment was developed under stabling conditions, in the corrals of the Herminio García González Zootechnical Station of the Faculty of Engineering and Sciences of the Autonomous University of Tamaulipas, located at km 23 of the road Cd. Victoria-Monterrey in the Güémez municipality, Tamaulipas; located geographically at 23 ° 56 '26.5 "LN, 99 ° 06' 59.9" LO and at 193 m a.s.l.

Management and distribution of animals: 74 sheep were used [Blackbelly (n=19), Katahdin (n=24) and Pelibuey (n=31)], which were placed in three separate pens with wire mesh, equipped with feeders and drinking troughs.

The base ration of the sheep was fresh orange peel (CFN), which was offered *ad libitum.* While the treatments consisted of the supplementation of 300, 450 and 600 g animal^{-1} day^{-1} of a concentrate containing 25.5% of crude protein and 2.70 Mcal kg^{-1} (Table 1).

At the time of birth the lambs were weighed and identified, then weighed weekly. Weaning was performed at approximately 60 days of age, so the weights were adjusted to 60 days, in addition to estimating the daily gain of pre-weaning weight. The adjustment of the weights was calculated according to the following formula (BIF, 2010):

$$PA \quad (days) = \frac{PR - PN}{DT} * DA + PN$$

Where: $PA_{(days)}$ = adjusted weight; PR = real weight; PN = birth weight; DT = elapsed days; and DA = days of adjustment.

Table 1. Distribution of the sheep according to the genotype and supplementation level

Genotype	Level of supplementation (g animal^{-1} day^{-1})	Number of animals
Blackbelly	300	6
	450	4
	600	9
Pelibuey	300	13
	450	10
	600	8
Katahdin	300	7
	450	9
	600	8

Response variables: birth weight, weaning weight adjusted to 60 days and pre-weaning daily weight gain.

Statistical model: the variables were analyzed with a general linear model for genotype, lamb sex, type of parturition and supplementation level. The interaction genotype x level of supplementation and the weight of the lamb at birth as a covariate (SAS, 2002):

$$Yijklm = \mu + Gi + Dj + Pk + Sl + GD(ij) + \beta(po) + Eijklm$$

Where: Y_{ijklm} = is the l-th observation of the i-th breed sheep, j-th level supplement and k-th type of delivery; μ = general mean; G_i = the effect of the i-th racial group of the lamb (Blackbelly=1, Pelibuey=2 and Katahdin=3); D_j = the effect of the i-th supplement level (300=1, 450=2 and 600=3); P_k = is the effect of the k-th type of birth (Single = 1 and Double = 2); S_l = the effect of the l-th sex of the lamb (male = 1 and female = 2); $GD_{(ij)}$ = genotype interaction x level of supplementation; $\beta_{(Po)}$ = effect of weight at birth (covariate); and E_{ijklm} = random error.

Preliminarily, a model was run where all the first-order interactions among all the factors were evaluated, and in those cases where they were not statistically significant, they were eliminated from the final model. In those cases where there was a significant effect of the source of variation, the Tukey test was applied at the level of P = 0.05 (SAS, 2002).

RESULTS

In the present study, birth weight was not significantly affected (P> 0.05) by any of the sources considered in the statistical analysis. The average birth weight was 2.50 ± 0.15 kg; the Katahdin lambs weighed 2.70 ± 0.20 kg, without being different from the other genotypes (Table 2). Contrary to what one might expect, the level of supplementation did not affect birth weight. Similarly, the type of delivery (single and double) did not affect birth weight. The single lambs weighed 2.81 ± 0.27 kg.

A negative result was observed in the Katahdin group, where the frequency of double births was lower (47%), compared to the sheep of the Blackbelly and Pelibuey groups (86 and 75%, respectively), without this factor being attributed to the variables studied.

On the other hand, the general mean for adjusted weaning weight was 9.25 ± 0.57 kg, as for the weight at birth none of the sources of variation were significant (P> 0.05), except for type of delivery (P <0.05). The Katahdin lambs showed the lowest weight (9.03 ± 0.66 kg), compared with the Blackbelly and Pelibuey ones, which are less selected breeds for meat production. Similarly, the lambs of the sheep that were in the treatment of 300 g of supplement^{-1} day^{-1} weighed 0.97 and 0.60 kg more than the lambs of the sheep that received the treatments of 450 and 600 g of supplement^{-1} day $^{-1}$, respectively (Table 2). Regarding the type of delivery in Table 2, it can be seen that lambs in simple calving weighed 10.66 ± 0.75

kg, exceeding lambs in twin delivery in 1.76 kg, differences that were significant (P <0.05); however, sex did not affect the weaning weight of the lambs (P> 0.05).

On the other hand, the average daily gain of pre-weaning weight was 0.11 ± 0.01 kg. The genetic group, the level of supplementation, the type of delivery and the sex of the lamb did not affect (P> 0.05) the response.

Table 2 shows the means of daily gain of pre-weaning weight for all the variables studied.

DISCUSSION

The mean of birth weight found in this study is within the limits published in the literature (Lucero *et al*., 2011, Hinojosa-Cuéllar *et al*., 2013, González-Domínguez *et al*., 2016). As in other studies (Macias-Cruz *et al*., 2012), the racial group did not affect the variance in birth weight. The racial groups were similar in the weight at birth, probably because at this stage the capacity to grow in the lambs is still not shown and it is more response of the intrauterine environment of each one of the sheep.

Contrary to what one might think, the level of sheep supplementation did not affect birth weight. Faustino-Lázaro *et al*. (2016) noted that the inclusion of up to 30% fresh lemon pulp did not affect the daily weight gain of the sheep. On the other hand, Villanueva *et al*. (2013) found that sheep who received diets with 15 and 20% fresh orange residue had better daily weight gains than those who received diets with 25 and 30% fresh orange residue.

Table 2. Productive behavior of lambs according to racial group, supplement level, type of parturition and sex

Genotype	Birth weight (kg)			Weaning weight 60 days (kg)		Daily gain of pre-weaning weight (kg)	
	N	Mean	EE	Mean	EE	Mean	EE
BB	20	2.36	0.17	9.45	0.44	0.12	0.01
Pb	32	2.50	0.09	9.17	0.66	0.11	0.01
Kth	24	2.70	0.20	9.03	0.66	0.11	0.01
Supplementation							
300	26	2.40	0.17	9.79	0.50	0.12	0.01
450	25	2.50	0.19	8.82	0.63	0.10	0.01
600	25	2.60	0.20	9.13	0.57	0.11	0.01
Type of birth							
Single	15	2.81	0.27	10.66 [a]	0.75	0.13	0.01
Double	61	2.45	0.08	8.90 [b]	0.35	0.11	0.01
Sex of the calf							
H	42	2.47	0.10	9.52	0.44	0.12	0.01
M	34	2.60	0.14	8.92	0.49	0.11	0.01

N = Number of observations; EE = Standard error; BB = Blackbelly; Pb = Pelibuey; Kth = Katahdin; [ab]Means with different superscript within factor are statistically significant (P < 0.05).

Otherwise, Zamora *et al*. (2015), found that the energy and protein supplementation in Blackbelly x Pelibuey lambs grazed, did not improve (P> 0.05) daily weight gains and as a result the birth weights of the calves. The variation in the results of the previous work could be associated with the quantity and quality of the food supplement to which the sheep have access in that period, as well as the differences in the prepartum and postpartum feeding systems of the mothers in connection with the quantity and quality of colostrum and milk.

The type of delivery in this study did not affect birth weight, even though in the literature it refers that it does affect (Hinojosa-Cuéllar *et al*., 2013). The explanation for this better growth is due to the fact that the lambs of single birth have no competence at the level of the uterus for nutrients from the mother and space.

Finally, the birth weight was not affected by the sex of the lamb; however, González-Garduño *et al*. (2010) found that the birth weight of Blackbelly lambs was affected by the sex of the young. These authors report that in the presence of the *Y* gene and the activation products of the *sry* gene (androgens and inhibitory substances of the Müller ducts) have a specific influence on fetal growth.

The adjusted weaning weight recorded in the present study is below that cited by Macias-Cruz *et al*. (2012) and González-Domínguez *et al*. (2016); it should be noted that the authors reported the weights of weaned lambs at 90 days of age. The differences in the prepartum and postpartum feeding of the sheep, as well as the quantity and quality of the food supplement to which the sheep had access, possibly contributed to partially explain the variation of the weight at adjusted weaning.

Contrary to what could be expected, the effect of the genotype did not affect the adjusted weaning weight, even though there were lambs of a race specialized in meat production (Katahdin); similar results are mentioned by Lucero *et al*. (2011) and Mellado *et al*. (2016). In the literature several works are cited where it is shown that adjusted weaning weight is affected by the genotype of lambs (Macias-Cruz *et al*., 2012; Hinojosa-Cuéllar *et al*., 2013).

Regarding the level of supplementation, it was observed that it did not affect the adjusted weaning weight. Similar results were reported by Lucero *et al*. (2011), when conducting an experiment with lambs of the Blakbelly and Katahdin genotypes and two levels of supplementation. It is documented that the development of lamb in the pre-weaning stage depends mainly on breast milk and its capacity to consume it. According to this, it could be assumed that the milk production of the sheep should cause a difference in the pre-weaning growth of their lambs.

In this study, the type of delivery affected the adjusted weaning weight; it was observed that the lambs in single birth were heavier than those of double birth. Similar results are reported

by Hinojosa-Cuéllar *et al*. (2013) and Mellado *et al.* (2016), who found that productive performance was superior in single lambs to multiple lambs (Hinojosa-Cuéllar *et al*., 2013).

Regarding lamb sex, no significant differences were observed in this study, results that do not coincide with what is cited in the literature (Macias-Cruz *et al*., 2012; Mellado et al., 2016).

Finally, the mean daily gain of pre-weaning weight was lower than that reported in the literature (Macias-Cruz *et al*., 2012, Hinojosa-Cuéllar *et al*., 2013, Mellado *et al*., 2016). In this experiment none of the sources of variation studied were important in the daily gain of pre-weaning weight; however, in the literature (Macias-Cruz *et al*., 2012; Hinojosa-Cuéllar *et al*., 2013) it is pointed out that the genetic group causes significant influences in pre-weaning daily gain. Contrary to what was expected, the supplementation level was not important in the daily gain of preweaning weight. The sheep did not show differences in milk production even though they had different supplementation levels and that should be reflected in the pre-weaning growth of the lambs.

Contradictory results to that of the present study were pointed out by Macias-Cruz *et al*. (2012) and Mellado *et al*. (2016) who found that preweaning daily gain was affected by the type of delivery.

In relation to the lamb sex, no differences were observed in pre-weaning daily gain. Even contrary results were found by Macias-Cruz *et al*. (2012), who found differences in daily weight gains in male and female lambs.

CONCLUSIONS

Under the conditions in which the present study was carried out, it can be concluded that lambs of the Blackbelly, Pelibuey and Katahdin breeds did not modify their productive responses regardless of the feeding conditions of their pre and postpartum mothers. In this study, only the type of delivery affected the adjusted weaning weight; however, it must be taken into account that simple lambs are less productive than twin births. Also, the use of fresh orange peel can be an unconventional food in the feeding of hair sheep.

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