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Influence of gender on carcass yield of twin lambs Blackbelly x Pelibuey at 56 days of age

[*Influência do gênero no rendimento de carcaça em cordeiros gêmeos* Blackbelly *x* Pelibuey *aos 56 días de idade*]

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ABSTRACT

The aim of this study was to determine the influence of gender on pre-weaning growth, yield and weight of primal cuts of the carcass of Blackbelly x Pelibuey lambs. 16 twin lambs were used. The lamb gender was the fixed factor. The variables evaluated were: body weight at birth and at weaning, average daily weight gain, weight and yield of carcass and primal cuts: neck, arm, thorax, abdomen and leg. Gender did not affect (P>0.05) body weight at birth. However, the pre-weaning average daily weight gain and body weight at weaning were affected (P<0.05) by the gender. Hot carcass yield and weight and primal cuts were not affected (P>0.05) by the gender of the lamb. Nevertheless, the area of the *Longissimus dorsi* muscle and cavity fat were different between males and females (P<0.05) 11.5±0.73cm^2 and 198±0.05 g *vs* 9.3±0.73cm^2 and 282±0.05g, respectively. In conclusion, in twin lambs Blackbelly x Pelibuey males had greater average daily weight gain and body weight at weaning than females. Carcass yield and weight and primal cuts were not affected by the gender of the lamb. However, males had greater area of the *L. dorsi* muscle than females and these in turn had a greater amount of cavity fat than males.

Keywords: carcass composition, ewe productivity, growth, hair sheep, humid tropic

RESUMO

Objetivou-se determinar a influência do gênero no crescimento pré-desmame, no rendimento e no peso dos cortes primários de carcaça de cordeiros Blackbelly *x* Pelibuey. *Utilizaram-se 16 cordeiros gêmeos. Os dados foram analisados em um desenho completamente ao acaso, em que o gênero dos corderos foi o fator fixo. As variáveis avaliadas foram: peso vivo ao nascimento e ao desmame, ganho diário de peso, peso e rendimento de carcaças e dos cortes primários: pescoço, braço, tórax, abdômen e perna. O gênero não afetou (P>0,05) o peso vivo ao nascimento. No entanto, o ganho diário de peso e o peso vivo ao desmame foram afetados, sendo esses valores superiores nos machos (P<0,05). O peso e o rendimento das carcaças quentes e dos cortes primários não foram afetados (P>0,05) pelo gênero do cordeiro. Entretanto, a área do músculo* Longissimus dorsi *e a gordura cavitária foram diferentes entre machos e fêmeas (P<0,05): 11.5±0.73cm^2 e 198±0.05g vs. 9.3±0.73cm^2 e 282±0.05g, respectivamente. Em conclusão, nos cordeiros gêmeos* Blackbelly *x* Pelibuey, *os machos tiveram maior ganho diário de peso e maior peso vivo ao desmame do que as fêmeas. O peso e o rendimento da carcaça bem como os cortes primários não foram afetados pelo gênero do cordeiro. Todavia, os machos tiveram maior área do músculo* L. dorsi *que as fêmeas e estas tiveram maior quantidade de gordura cavitária que os machos.*

Palabras-chave: composição carcaça, productivida de ovelhas, crescimento, ovinos de pêlo, trópicos úmidos

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INTRODUCTION

The high price of a balanced feed to fatten sheep and value acquired by finishing sheep (standing) has slowed the growth of sheep inventory in Mexico. These circumstances make it necessary to seek alternatives for nutritional management and marketing alternatives to improve the final price of sheep in order to obtain greater commercial benefit for producers. One option is to diversify meat products of ovine origin at an early age (young lambs) in order to reduce feeding costs in the production system and that these products gain greater economic value. However, there are several factors such as genotype, birth type, lambing weight, lambing season, gender, age of lamb at weaning and lambing number (Hinojosa-Cuellar *et al.*, 2009, 2012; Ríos-Utrera *et al*., 2014) that can influence the growth of lambs and their final body composition (carcass and / or meat).

In the case of hair sheep breeds there is information documenting the influence of gender on pre-weaning growth (Ríos-Utrera *et al*., 2014). However, there is no information on the carcass yield and composition of these lambs at ages below 70 days. Studies on yield and body composition of hair sheep have been conducted in stages after weaning under different feeding systems (Combellas, 1997; Partida *et al*., 2009; Macías-Cruz *et al*., 2010). In addition, in studies evaluating the lamb growth the productive performance of ewes during lactation or their subsequent reproductive behavior is not documented.

Therefore, the aim of this study was to determine the influence of gender of twin lambs on pre-weaning growth, yield and weight of primal cuts of the carcass of lambs Blackbelly x Pelibuey slaughtered at 56 days of age. Collaterally, productive and reproductive performance of ewes are described.

MATERIALS AND METHODS

The study was carried out in a sheep farm located in Huimanguillo, Tabasco, México (17° 50' N and 93° 23' W), where the climate is warm and humid with rainfall throughout the year (Af) and an annual average ambient temperature of 27.8°C (Anuario…, 2007).

Sixteen twin lambs (females=7 and males=9) Blackbelly x Pelibuey born in summer, from eight multiparous ewes with eight lambings were used. The data were analyzed on a completely randomized design having as a fixed factor the lamb gender. Protocol was reviewed and approved by the Institutional Animal Care and Use Committee at Centro de Investigación Regional Golfo Centro, Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias.

Lambs remained stabled during the whole lactation stage and were fed by controlled suckling, commercially available dietary supplement (starting from five days old, 18% CP) and free access *Cynodon plectostachyus* and *Gliricidia sepium* hay (starting from 15 days old). Controlling access to suckling was applied starting from the second week of the lamb life and consisted in restricting access of lambs to suckling for six hours (8:00 to 14:00). From the third week and to conclude lactation, lambs did not have access to suckling during ten hours (08:00 to 18:00).

To calculate the pre-weaning average daily weight gain (ADWG), lambs were weighted at birth and at weaning (56 days old).

At 56 days of age, lambs were slaughtered with a previous non-dairy feed fasting of 14 hours (Martínez *et al*., 1987). Hot carcass weight and internal fat in the abdominal and pelvic cavities (omentum-mesenteric and peri-renal) (Martínez *et al*, 1987; Hernández-Espinoza *et al*, 2012) were recorded. Subsequently, the carcass was divided into five primal cuts (neck, arm, thorax, abdomen and leg) according to the methodology of Martínez *et al*. (1987).

The empty weight corresponded to the difference in kg between weight at slaughter and weight of digestive contents, the latter was obtained as a result of obtaining the difference between the full and empty weight of the gastrointestinal tract (rumen, reticulum, omasum, abomasum, small intestine and large intestine). The carcass yield (%) was obtained by the equation (carcass weight/slaughter weight) x 100. The real yield (%) was the ratio (carcass weight/empty weight) x 100 (Martínez *et al*., 1987). The area of the *Longissimus dorsi* muscle was measured between the 12^{th} and 13^{th} rib by a plastic gridded film in cm^2 (García *et al*., 1998).

The variables evaluated in lambs were: body weight at birth (BWB), body weight at weaning (BWW), ADWG, weight and yield of hot carcass and real, area of *L. dorsi* muscle, weight and yield of primal cuts (neck, arm, thorax, abdomen and leg) cavity fat, head and skin. Additionally, the weight of the liver, the empty gastrointestinal tract (EGIT) and the reticulum-rumen-omasum-abomasum (RROA) section were recorded.

The ewes were maintained on grazing (*C. plectostachyus*) and supplemented as a group with commercial feed (300 g/ewe/d, 15% CP) 30 days before the probable lambing date. On the first week of lactation, ewes remained stabled with their litters and were fed hay *C. plectostachyus*. On the second week of lactation, ewes came out to graze (8:00 to 14:00) and the rest of the day they were with their litters (receiving hay *C. plectostachyus*). From the third week until the end of the lactating stage ewes were grazing for 10 hours (8:00 to 18:00). During the entire lactation stage ewes were supplemented as a group with a commercial feed (500 g/ewe/d, 15% CP). Grazing was carried out in pastures with *C. plectostachyus*. On average, the occupation period was three days in each pasture and 25 days off.

To calculate average daily weight gain of females during the study period the ewes were weighed at lambing and at the end of lactation. Body condition was assessed using a scale from one to five (Thompson and Meyer, 1994). The litter weight at birth and weaning were recorded. The latter value was used to calculate the production efficiency of ewes through the relationship: litter weight at weaning, kg/ewe weight at 56 d pospartum, kg (Vivanco-Makie, 2011).

Reproductive management (once all ewes ended their lactation) was applied to ewes as a group during the summer. Oestrus detection was performed twice daily (7:00 and 18:00 h) for 42 days, based on the presence of an adult Blackbelly ram. Immobilization of the female at mounting by the male was considered a sign of oestrus behavior (Jainudeen and Hafez, 1996). When an ewe in oestrus was detected, this was mated with only one ram for three times at 12h intervals. During mating four adult Blackbelly rams were used and it was attempted to mate them with a similar number of ewes.

Reproductive efficiency was evaluated using the following variables: interval lambing, first oestrus detected, interval lambing conception and interval between lambings (eighth to ninth lambing).

The data were analyzed in a completely randomized design having the lamb gender as a fixed factor. Previously, the Shapiro-Wilk's test was applied to data to prove that they were distributed normally and the Bartlett's test to verify homogeneity of the variances. Data from lambs were analyzed as a mixed model, where the fixed factor was the gender of the offspring and the random factor was the mother. In BWW and ADWG the model included BWB as a covariate ($P<0.05$), while in primal cuts the model included carcass weight as a covariate ($P<0.05$). For data analysis the MIXED procedure was used (SAS®, SAS, Institute Inc., Cary, NC, USA). The least square means were compared with the predicted differences method using the t-test. The values of the least square means were considered statistically significant when $P<0.05$. In ewes data, the mean ± standard deviation was obtained (SAS®, SAS, Institute Inc., Cary, NC, USA).

RESULTS

The twin lamb gender did not affect ($P>0.05$) BWB. However, male lambs had higher ADWG pre-weaning and BWW ($P<0.05$) than females (Table 1).

Table 1. Influence of gender on pre-weaning growth of twin lambs Blackbelly x Pelibuey

Variable	Gender	
	Male	Female
Body weight at birth, kg	2.8±0.15	2.8±0.16
Body weight at weaning (56 d), kg	13.2±0.66[a]	12.2±0.68[b]
Average daily weight gain, g	186±12[a]	167±12[b]
Number of observations	9	7

Least squares mean±standard error in the same row with different superscript letters are significantly different ($P<0.05$).

Hot carcass weight and primal cuts as well as hot carcass yield were not affected (P>0.05) by the gender of the lamb (Table 2). Regarding the area of the *L. dorsi* muscle and cavity fat, both were different between both sexes (P<0.05). Male lambs showed higher values in area of the *L. dorsi* muscle, while females had higher amount of cavity fat in relation to male lambs (Table 2).

Male lambs showed a greater weight (P<0.05) of EGIT compared to females (Table 2). However, liver and RROA weights were not affected by gender (P>0.05).

The yields of carcass primal cuts, were not affected (P>0.05) by the gender of the lamb. The means ± standard deviation were: neck 7.1±1.5%, arm 18.7±1.3%, thorax 26.1±2.1%, abdomen 22.3±1.6% and leg 24.5±1.5%.

The productive and reproductive efficiency of ewes after their eighth lambing is shown in Tab. 3.

Table 2. Influence of gender on the body composition at weaning of twin lambs Blackbelly x Pelibuey

Variable	Gender	
	Male	Female
Age at slaughter, d	56	56
Empty body weight[1], kg	11.6±0.61	10.9±0.66
Carcass weight, kg	6.0±0.33	5.7±0.36
Carcass yield[2], %	46.2±0.51	46.7±0.58
Carcass real yield[3], %	52.5±0.45	52.4±0.51
Neck, kg	0.44±0.04	0.39±0.04
Arm[4], kg	1.14±0.03	1.07±0.03
Leg[4], kg	1.45±0.03	1.44±0.04
Thorax, kg	1.55±0.05	1.53±0.05
Abdomen, kg	1.33±0.04	1.31±0.04
Area of *Longissimus dorsi* muscle, cm^2	11.5±0.73[a]	9.3±0.73[b]
Cavity fat, g	198±0.05[a]	282±0.05[b]
Head, kg	0.64±0.03	0.59±0.03
Skin, kg	1.3±0.11	1.3±0.12
Liver, g	265±18	225±20
EGIT, g	1196±55[a]	999±63[b]
RROA, g	432±31	404±31
Number of observations	9	7

1, empty body weight: body weight at slaughter-weight of digestive contents; 2, carcass yield: (carcass weight/body weight at slaughter) x100; 3, carcass real yield: (carcass weight/empty body weight) x 100; 4, refers to the weight of the two arms or legs; EGIT: empty gastrointestinal tract; RROA: reticulum-rumen-omasum- abomasum; [a, b] Least squares mean ± standard error in the same row with different superscript letters are significantly different (P<0.05).

Table 3. Changes in body weight and body condition (mean ± standard deviation) in lactating multiparous Blackbelly x Pelibuey ewes

Variable	
Weight at lambing, kg	41.5±4.7
Weight at 56 d pospartum	38.8±3.9
Average daily weight gain, g	-48±40
Body condition at lambing	3.1±0.7
Body condition at 56 d pospartum	2.5±0.8
Body condition change	-0.56±0.7
Litter weight at birth, kg	5.57±0.6
Litter weight at weaning, kg	25.51±0.7
Productivity [1]	0.66±0.09
Interval lambing first oestrus, d	86.6±16.3
Interval lambing conception , d	89.4±16.9
Interval between lambings, d[2]	240.9±17.2
Number of observations	8

1, productivity: litter weight at weaning (56 d), kg/body weight of the ewe at 56 d pospartum, kg; 2, eighth to ninth lambing.

DISCUSSION

Information to study the influence of the twin lamb gender of hair breed on BWB was not found. Notwithstanding, the results of this study are consistent with those reported by González-Garduño *et al*. (2010) and Hinojosa-Cuéllar *et al*. (2012) who indicate that in Pelibuey lambs the gender of the lamb does not influence birth weight. However, there are studies about hair sheep (González *et al*., 2002; Ríos-Utrera *et al*., 2014) indicating that the superiority of male lambs in BWB compared to females, is found between 3.7 and 8.5%.

The superiority of male lambs in ADWG pre-weaning and BWW compared to females is consistent with that indicated by Ríos-Utrera *et al*. (2014) in lambs of six racial groups, with an adjusted weaning at 90 days, fed with maternal milk and a supplement (18% CP), where male lambs showed a higher ADWG and BWW (98±4 g and 11.7±0.4 kg, respectively) than that of females (94±4 g and 11.1±0.4 kg, respectively). This effect of gender on ADWG and BWW has also been reported in Blackbelly (González *et al*., 2002) and Pelibuey lambs (Macedo and Arredondo, 2008).

Male and female lambs had similar weight and hot carcass yield. In this regard, Peña *et al*. (2005) report that in Segureña breed lamb (average age of 79 days) gender did not influence the weight and hot carcass yield which agrees with the results obtained in this research. However, hot carcass weights, carcass yield, and real yield reported by these authors for males and females was higher (10.5±0.1 kg, 48.8±0.3% and 54.5±0.3% in males and 10.4±0.1 kg, 49.0±0.3 and 55.1±0.3% in females, respectively) than those obtained in this study (Table 2). Meanwhile, Combellas (1997) indicates that in West-African lambs (71 days of age) there is a hot carcass weight of 7.8 kg, a carcass yield of 50.5% and a real yield of 56.8%, values that are also higher than those recorded in the present study. Differences in carcass weight and carcass yield between studies are explained, in part, by the slaughter age, racial group and feed regime to which the lambs were subjected.

The area of the *L. dorsi* muscle was greater in male lambs than females. In contrast to the results of this study, Macías-Cruz *et al*. (2010) when evaluating carcasses of lambs (average age 233 days) from three racial groups found no influence of lamb gender on *L. dorsi* muscle reporting values of 15.9±0.7 and 17.0±0.7cm^2 for females and males, respectively. Moreover, in lambs (79 days old) of the Segureña (Peña *et al*., 2005) and Suffolk Down breed (between 23 and 30 days of age) (Pérez *et al*., 2002) it has been reported that the area of the *L. dorsi* muscle is not affected by lamb gender.

The values obtained for the cavity fat contrast with the results of Partida *et al*. (2009) who indicate that in genotypes Pelibuey, Pelibuey x Suffolk and Pelibuey x Dorset deposits of omental and mesenteric fat showed no significant differences between females and males. However, a tendency to be higher in females was observed.

The EGIT was greater in male lambs than females. However, it is still necessary to determine whether a heavier weight of the gastrointestinal tract shows a relationship with increased absorption surface and/or rumen function that will improve the ability to digest and convert ingested food into muscle tissue.

The yields of carcass primal cuts were not affected by the gender of the lamb. In a similar manner to these results, Pérez *et al*. (2002) indicate that in Suffolk Down lambs gender did not influence the yield of primal cuts. However, in lambs of the Segureña breed it has been reported that gender influences the neck and shoulder yield being greater in males (Peña *et al*., 2005). Macías-Cruz *et al*. (2010) reported that gender affected rib and shoulder yield. Males had a higher shoulder yield and females had a higher rib yield. Information of these two authors differs from the results obtained in the present study. Differences are probably attributed to genotypes, age and feeding system of evaluated lambs.

Weights of studied ewes are found within the body weight variation reported in adult Pelibuey (31.7±3.7) (Martínez *et al*., 1987) and Blackbelly (35.0±6.5kg) ewes (Dzib *et al*., 2011). During lactation ewes had a negative ADWG, which was reflected in body condition and body weight at the end of lactation. The negative ADWG and reduction in body condition of the ewes indicate that the feeding system used did not meet the nutrient requirements to support lactation of

lambs. In agreement with the above result, Morales-Terán *et al*. (2004) and Pérez *et al*. (2009) show that Pelibuey multiparous ewes (whose litters had access to continuous suckling) had a negative weight change during the first 56 days of lactation in the order of 1.9kg (Morales-Terán *et al*., 2004) and 2.5kg (Pérez *et al.,* 2009). While Espinoza *et al*. (1998) indicate that when offering the Pelibuey multiparous ewes (suckling a single lamb) 5.2Mcal EM/ewe/d a positive weight change (0.5 to 2.7kg) is achieved during the first 60 days of lactation.

As to the litter weight, Cadenas-Cruz *et al*. (2012) report the hybrid litters (Pelibuey x Blackbelly) from Blackbelly ewes in their eighth lambing weight at birth 4.0±0.2kg and at weaning (fitted at 90 days of age) 14.3±0.6, while in the case of litters with two lambs, Rastogi (2001) reports that in the Blackbelly breed these weight 17.6kg at 56 days of age and Magaña-Monforte *et al*. (2013) state that in the Pelibuey breed the litter weight at weaning (fitted at 60 days) with two lambs is 22.0kg, values which are lower to those found in the present study. The pre-weaning ADWG of lambs and litter weight at weaning recorded in the present study suggest that allowing lambs free access to a food supplement plus *C. plectostachyus* and *G. sepium* hay during the control period of lactation does not affect productive performance.

Of the eight ewes studied only one ewe repeated estrous behavior. However, all the ewes had a subsequent lambing (ninth lambing). In Pelibuey multiparous ewes that suckle their offspring *ad libitum* the first ovulation and the proportion of ewes showing ovulation is variable. Pérez *et al*. (2009) indicate that the first ovulation occurs on average at 52.6 days postpartum in 18.8% of the ewes; while Morales-Terán *et al*. (2004) point out that the first ovulation occurs at 60.5 days postpartum in 70% of the ewes. Furthermore, Cadenas-Cruz *et al*. (2012) reported that in Blackbelly ewes suckling continuously their litter and that were exposed to the continuous presence of rams for mating during the postpartum period, 72.4% achieve conception within 90 days and 84.1% before 120 days postpartum. In the present study, ewes were exposed to rams at 75±15.9 days postpartum and achieved conception at 89±16.9 days postpartum which agrees with that reported for Blackbelly ewes (Cadenas-Cruz *et al*., 2012).

Moreover, ewes showed an interval between lambings within the limits (230 and 260 days) reported on commercial sheep farms in the tropical region of Mexico (Galina *et al.,* 1996; Hinojosa-Cuéllar e*t al*., 2015; Magaña-Monforte *et al*., 2013). Additionally, the detected interval value between lambings was similar to that indicated (240 days) as optimal to achieve three lambings in a period of two years (Magaña-Monforte *et al*., 2013).

CONCLUSIONS

Pre-weaning growth in twin Blackbelly x Pelibuey lambs is influenced by gender. Male lambs show superiority in their average daily weight gain, body weight at weaning and area of *Longissimus dorsi* muscle compared to females. Carcass weight and yield as well as primal cuts are not affected by lamb gender. Moreover, the feed system and management of the lactation used in multiparous Blackbelly x Pelibuey ewes caused that these showed a change of negative weight and a reduction of their body condition. However, they managed to be efficient productively and reproductively.

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