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Carcass characteristics of Criollo Cordobés kid goats under an extensive management system: Effects of gender and liveweight at slaughter

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ABSTRACT

Thirty males and thirty females suckling Criollo Cordobes kid goats of approximately 60 to 90 days old were used in this study. Kids were slaughtered at <9.5 kg, >9.5<11 kg and >11 kg of empty body weight. The carcasses showed a medium conformation index. The meat and fat colour, and internal subcutaneous fatness were mainly scored as either pink, cream, slight and low-medium, respectively. The shoulder comprised 66–67% muscle, 24–27% bone and 4–6% fat. The slaughter weight had significant effects on the following characteristics: dressing yield, carcass measures and indices, subcutaneous fatness, meat colour, and muscle/fat ratio. The effect of gender was smaller: the female kids presented the highest fatness values for all parameters studied. Also, these animas displayed the lowest percentage of joints of extra class. The meat of female kids contained significantly less muscle and bone and a higher proportion of fat than that of male kids.
The allometric analysis displays an early growth in the carcass measures and indices, fifth quarter, joints and bone proportion of shoulder. Internal and dissectible fats show a late growth.
Principal component (PC) analysis was performed to study the relationship between carcass quality variables. The six first PC's explained about 85% of the total variability. The weight and yield of the carcasses were more effective to define the first PC. The projection of the carcass quality data in the first two PC's allowed distinguishing between carcass weight and carcass conformation groups, but not between gender and fatness.

1. Introduction

The goat population of Argentina is mostly located in smallholder farming areas, and their function is the production of meat. The traditional production system is extensive, with grazing on natural grassland with shrubs and forest and with little or no feed supplementation (Maubecin, 1976). The kids are raised with their mothers and slaughtered at 1–7 months old and 6–15 kg carcass weight; although in the present, has reduced the age/weight at slaughter (30–65 days old and 6–12 kg liveweight, Arias, & Alonso, 2002).

The Creole Argentine goat is a descendant of the Iberian introduced in Argentina from Peru by the Spanish conquerors in the sixteenth century. The different crossbreedings made and their adaptation to different habitats are the main causes of the appearance of ecotypes (Sanluiseño, Cordobés, Patagónico, de Neuquén, etc.) within Creole goat (Rossanigo, Frigerio, & Silva Colomer, 1995; Bedotti, 2000; Lanari, Domingo, Pérez Centeno, & Gallo, 2005). The Criollo Cordobés goat (4.4% of last official census; INDEC, 2002) is a rustic genotype adapted to the environmental conditions of the province of Córdoba, in the central-western Argentina, with defined genetic and phenotypic characteristics (Deza, Balzarini, Varela, Villar, & Barioglio, 2002;Deza, Bascur, Pérez, Díaz, & Barioglio, 2003).

The origin of the animals, carcass characteristics and meat quality are important criteria for consumers when it comes to making purchasing decisions. Therefore, the producers are encouraged to continue producing according to the traditional systems and methods because the products are well accepted to the consumers. Carcass classification for conformation and fatness are the main parameters for determining the marker price. However, the goat marketing system in Argentina is poorly developed and lack appropriate means of carcass evaluation (De Gea, 2000).

Several studies have been conducted to characterise the production systems, and morphological, carcass and meat traits of Creole goats (Maubecin, 1976; Dayenoff, & Bolaño, 1993; Gallinger, Dayenoff, & Garriz, 1994; Rossanigo et al., 1995; Rossanigo, Frigerio, & Silva Colomer, 1996; Bedotti, 2000), and very few on the Criollo Cordobés (De Gea, Petryna, Mellano, Bonvillani, & Turiello, 2005). Therefore, new studies are needed to improve our knowledge of carcass and meat quality of native goats to propose a grading system and to obtain protected origin designation (POD). Additionally, there is a little amount of published information on the potential of increased slaughter weight to maximize goat meat production.

The aim of this work is to characterise carcasses from Criollo Cordobés kids at different weights/ages and to propose a classification

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system for carcasses to improve market transparency which will establish market prices according to objective criteria.

2. Material and methods

2.1. Location

The study was conducted at the Faculty of Agronomy and Veterinary (University National of Rio Cuarto, Córdoba, Argentina) (between latitude 29° and 35° S, and between longitude 61° and 65°O).

2.2. Animals and management

Sixty Criollo Cordobés kids, thirty males and thirty females, approximately 60 to 90 days old and 9–15 kg liveweight, were used in this work. The kids came from several farms and were produced according to the traditional system of the region. The kids were naturally suckled and left to graze with their dams, and were randomly assigned to three different live weight groups: low (<11 kg), medium (≥11<13 kg) and high (≥13 kg). When kids reached the slaughter live weight, they were separated from their dams and transported to the abattoir (5 km away).

2.3. Slaughter

Immediately after arrival at the abattoir, the kids were kept in covered yards, deprived of food (for 12 h) and with free access to water. After weighing (slaughter live weight, SLW), the kids were electrically stunned and slaughtered according to standard commercial procedures. The dressed carcass comprises the body after removing the skin, head (at the occipital–atlantal joint), fore feet (at the carpal–metacarpal joint), hind feet (at the tarsal–metatarsal joint) and the viscera. Tail, thymus, lateral portion of the diaphragm, kidneys, perinephric and pelvic fats, testes in males and udders in females were retained in the carcass.

2.4. Carcass measurements

Hot carcass weight (HCW) and weight of “fifth quarter” (head, skin, feet, some visceral organs, and fat depots) were recorded within 1 h *post-mortem*. The cold carcass weight (CCW) was recorded 24 h later at a temperature of 4 °C, and the refrigeration losses were calculated. Empty body weight (EBW) was calculated by deducting the weight of digesta.

After chilling the carcasses (24 h at 4 °C), carcass fatness (subcutaneous and internal fat), and meat and subcutaneous fat colour were subjectively evaluated. The subcutaneous fat colour (1 = white; 2 = cream; 3 = yellow), lean colour (1 = pale; 2 = pink; 3 = red) and subcutaneous fat (1 = low; 2 = slight; 3 = average; 4 = high; 5 = very high) were subjectively evaluated using the scoring system suggested by Colomer-Rocher, Morand-Fehr, and Kirton (1987). The internal fat cover was subjectively assessed using a scoring system, taking the pelvic-renal fat as a whole (1 = low; 2 = average; 3 = high).

The dressing percentages were calculated as follows:

$$HCW/SLW(\%) = (\text{hot carcass weight} \times 100)/\text{slaughter live weight}$$

$$HCW/EBW(\%) = (\text{hot carcass weight} \times 100)/\text{empty body weight}$$

$$CCW/SLW(\%) = (\text{cold carcass weight} \times 100)/\text{slaughter live weight}$$

$$CCW/EBW(\%) = (\text{cold carcass weight} \times 100)/\text{empty body weight}$$

Objective carcass conformation measurements and indices, as described by Palsson (1939) and Boccard, Dumont, and Peyron (1958), were as follows: internal carcass length (L: length from cranial edge of the symphysis pelvis to the cranial edge of the first rib), hind limb length (F: length from perineum to distal edge of the tarsus), buttock width (G: widest buttock measurements in a horizontal plane on the hanging carcass), buttock perimeter (BG: maximum perimeter at G), thoracic perimeter (PT: maximum perimeter at Wr), thoracic depth (Th: maximum distance between thoracic vertebra), thoracic width (Wr: widest carcass measurements at the ribs), maximum rib width (Wth), carcass compactness (HCW/L, CCW/L), hind limb compactness (G/F), L/G, Wr/Th, Wth/Th, Th/L, Th/G, and L/PT. The cross-section of the 13th rib for maximum width (*A*: maximum distance from the medial border to the lateral extremity of *longissimus*) and depth (*B*: maximum distance perpendicular to the width) of the *m. longissimus* were measured with a calliper, and ribeye area was calculated $((A/2)\times(B/2)\times\pi)$.

2.5. Carcass dissection

After chilling, the carcasses were split along the vertebral column in two halves, and the left side was used for all measurements. Carcass left side weight was recorded (CLSW). The left side of each carcass was divided into five anatomical regions (shoulder, long leg, ribs, flank and neck) using a standard technique (Colomer-Rocher et al., 1987). The weight of the joints were recorded, expressed as proportion of the left-half-carcass weight, and grouped into three categories: extra (leg and ribs), first (shoulder) and second (neck and flank). The tail, testes, kidney, pelvic-perirenal fat in the carcass left side was removed before jointing and weighed. The shoulder was separated into dissectible fat (subcutaneous and intermuscular), muscle, bone and the remaining tissues (major blood vessels, ligaments, tendons and fascias).

2.6. Data analysis

The effect of sex (male, female) and live weight groups (<11 kg; ≥11<13 kg, ≥13 kg) on carcass traits were analysed by ANOVA using the General Linear Model (GLM) procedures of the SAS statistical package (SAS, 1999). While comparing males and females, empty body weight was used as covariate for analysis of carcass measurements, non-carcass components and dressing percentages; while hot carcass weight was used as covariate for analysis for primal cuts and dissectible tissues. Least-squares means (LSM) and their standard errors were computed and tested for treatments differences. No significant sex × empty body weight interactions were noted for the parameters evaluated in the present study, therefore, only the main effects are presented and discussed. The analysis of the qualitative variables was conducted using bivaried contingency tables, and chi-square tests.

Using empty body weight and hot carcass weight as independent variables (x), the relative growth coefficients (b) for carcass and non-carcass components and dissectible tissue composition (y) were calculated from the equation of Huxley ($\log y = \log a + b \log x$). An allometric coefficient higher than 1.0 ($b>1$) indicates late development, whereas an allometric coefficient lower than 1.0 ($b<1$) indicates early development.

A correlation, principal component and multivariate discriminant analysis was performed using the Proc CORR and Princomp procedure from the SAS (1999) package and the SPSS (2007), respectively.

3. Results and discussion

3.1. Body weight and dressing percentages

Mean values obtained for slaughter live weight (SLW), empty body weight (EBW), hot carcass weight (HCW), cold carcass weight (CCW) and dressing percentages of Criollo Cordobés kids used in this study are presented in Table 1. Gender did not have an effect ($p>0.05$) on most of the variables studied, while ($p<0.05$) were found among weight classes. Refrigerated losses were higher ($p<0.01$) in male kids than female kids, and decreased with slaughter weight.

Table 1
Least-squares means (±S.E.) of slaughter live weight (kg), empty body weight (kg), chilling losses (%) and dressing percentages in Criollo Cordobés kids.

	Sex		Weight at slaughtering			Effects	
	Males	Females	Group I	Group II	Group III	Sex	Weight
SLW	11.9 ± 0.3	11.6 ± 0.3	10.0^{a} ± 0.1	11.4^{b} ± 0.1	13.5^{c} ± 0.2	ns	***
EBW	10.4 ± 0.3	10.0 ± 0.2	8.5^{a} ± 0.9	9.9^{b} ± 0.7	11.8^{c} ± 0.2	ns	***
HCW	5.9 ± 0.2	5.7 ± 0.2	4.7^{a} ± 0.1	5.6^{b} ± 0.1	6.8^{c} ± 0.2	ns	***
CCW	5.7 ± 0.2	5.6 ± 0.2	4.6^{a} ± 0.1	5.5^{b} ± 0.1	6.7^{c} ± 0.1	ns	***
Chilling losses	3.7 ± 0.3	2.6 ± 0.2	2.7^{a} ± 0.2	1.8^{a} ± 0.2	1.51^{b} ± 0.1	**	**
HCW * 100/SLW	47.8 ± 0.5	47.7 ± 0.5	46.0^{a} ± 0.6	47.5^{a} ± 0.5	49.4^{b} ± 0.5	ns	**
HCW * 100/EBW	55.0 ± 0.5	55.5 ± 0.4	53.9^{a} ± 0.5	54.8^{a} ± 0.5	56.8^{b} ± 0.5	ns	**
CCW * 100/SLW	49.1 ± 0.5	49.0 ± 0.5	47.3^{a} ± 0.6	48.8^{b} ± 0.5	50.5^{c} ± 0.6	ns	**
CCW*100/EBW	56.4 ± 0.4	57.0 ± 0.4	55.4^{a} ± 0.1	56.3^{a} ± 0.5	58.1^{b} ± 0.5	ns	**

Note: $^{a, b, c}$ means within a row within sex or weight class, not followed by the same superscript differ ($p<0.05$). SLW = slaughter liveweight; EBW = empty body weight.
HCW = Hot carcass weight; CCW = Cold carcass weight.
Chilling losses = (HCW − CCW) × 100/HCW.
ns = not significant; *$p<0.05$; **$p<0.01$; ***$p<0.001$.

Dressing proportions were within the range noted (46–56%) by Garriz, Gallinger, and Dayenoff (1994), Gallo, Le Breton, Wainnright, and Berkhoff (1996), Rossanigo et al. (1996), Meneses, Pérez, Pittet, Galleguillos, and Morales (2001), Zimerman, Domingo, and Lanari (2008) in Creole kids and within those found in different genotypes at similar carcass kids weight (45–53%) by (Mahgoub, & Lu, 1998; Colomer-Rocher, Kirton, Mercer, & Duganzich, 1992; Dhanda, Taylor, & Murray, 2003a,b; Peña, Perea, García, & Acero, 2007), slightly higher than those reported (44–47%) by Pérez, Maino, Morales, and Soto (2001), Marichal, Castro, Capote, Zamorano, and Argüello (2003) and Argüello, Castro, Capote, and Solomon (2007), and lower than those obtained by Leguiza, Chagra, and Vera (2001) in Criollo kids (59.6–61%) and Todaro et al. (2006) in Girgentana kids (64.7–65.2%). Also, these values are lower than those obtained (50–56%) in kids reared in intensive systems (Fehr, Sauvant, Delage, Dumont, & Roy, 1976; Kosum, Alçiçek, Taskin, & Önenc, 2003), which can be attributed to their higher fatness (Manfredini, Massari, Cavani, & Falaschini, 1988). Better rearing practices can be achieved through nutritional management, which would improve the dressing percentage of Criollo Cordobés kids. In agree with Peña, Gutiérrez, Herrera, and Rodero (1994b) and Santos et al. (2007), dressing proportion was higher ($p>0.05$) in females, which can be explained by their tendency to have a higher fat deposition in the carcass (Tables 4 and 5). On the contrary, Pérez et al. (2001) recorded higher values in males than females (54% vs. 50%). The differences between these studies may be due to the type of diet and weight at slaughter.

In the present study, dressing proportions increased ($p<0.01$) with slaughter weight, in disagreement with Peña et al. (2007) who found no differences in dressing percentages of Florida suckling kid goats slaughtered at 7–8, 10–11 and 14–15 kg liveweight. Marichal et al. (2003) noted an increase of dressing percentage in kids slaughtered at 6 and 10 kg live weight (50.3 to 52.9%).

Refrigerated losses were similar ($p>0.05$) between sexes. As observed in the present study, variation in the chilling losses between different slaughter weights (3.6 to 2.4% and 3.2 to 2.1%) have already been reported by Marichal et al. (2003) in the Canary Caprine Group breed and Peña et al. (2007) in the Florida breed. With an increase in slaughter weight, a significant ($p<0.01$) decrease was observed in chilling losses. We attributed this to a reduction in the body surface/body weight ratio and to the thicker subcutaneous fatness of the carcasses.

3.2. Carcass measurements and indices

The values of carcass measures and indices (Table 2) show elongated carcasses with medium conformation, which conform with results obtained in previous studies for Creole kids at similar or higher slaughter weight (Garriz et al., 1994; Moreyra et al., 1998; Meneses, Rojas, Flores, & Romero, 2004; De Gea et al., 2005; Argüello et al., 2007; Domingo,

Table 2
Least-squares means (±S.E.) of carcass measures (cm) and indices of Criollo Cordobés kids carcasses.

	Sex		Weight at slaughtering			Effects	
	Males	Females	Group I	Group II	Group III	Sex	Weight
F	29.4 ± 0.2	29.3 ± 0.3	28.2^{a} ± 0.3	29.0^{a} ± 0.3	30.5 ± 0.3^{b}	ns	**
L	46.1 ± 0.4	46.5 ± 0.5	43.9^{a} ± 0.5	46.3^{b} ± 0.4	47.8^{c} ± 0.5	ns	***
G	10.9 ± 0.1	10.8 ± 0.1	10.0^{a} ± 0.1	10.9^{b} ± 0.1	11.5^{b} ± 0.1	ns	**
Wr	11.7 ± 0.2	11.7 ± 0.2	11.5^{a} ± 0.2	11.4^{a} ± 0.2	12.2^{b} ± 0.2	ns	**
Wth	11.1 ± 0.2	11.0 ± 0.2	10.4^{a} ± 0.2	10.7^{a} ± 0.2	12.0^{b} ± 0.2	ns	**
Th	20.2 ± 0.2	19.9 ± 0.2	18.9^{a} ± 0.2	19.8^{b} ± 0.2	21.2^{c} ± 0.2	ns	**
BG	39.1 ± 0.6	39.0 ± 0.6	35.5^{a} ± 0.4	38.6^{b} ± 0.5	42.2^{c} ± 0.5	ns	***
PT	49.7 ± 0.4	48.9 ± 0.5	46.5^{a} ± 0.4	48.9^{b} ± 0.2	51.7^{c} ± 0.4	ns	**
A	4.1 ± 0.1	3.9 ± 0.1	3.7^{a} ± 0.1	4.0^{b} ± 0.1	4.7^{c} ± 0.1	*	*
B	2.4 ± 0.1	2.5 ± 0.1	2.2^{a} ± 0.1	2.5^{ab} ± 0.1	2.6^{b} ± 0.1	ns	*
Ribeye area	7.87 + 0.27	7.74 ± 0.28	6.54^{a} ± 25	7.65^{b} + 0.23	9.16^{c} ± 0.29	ns	***
L/G	4.24 ± 0.03	4.31 ± 0.05	4.39^{a} ± 0.05	4.27^{ab} ± 0.05	4.18^{b} ± 0.04	ns	*
L/PT	0.93 ± 0.01	0.95 ± 0.01	0.94 ± 0.01	0.95 ± 0.01	0.92 ± 0.01	*	ns
Th/G	1.86 ± 0.04	1.80 ± 0.03	1.81 ± 0.08	1.79 ± 0.03	1.89 ± 0.03	ns	ns
G/F	0.37 ± 0.01	0.37 ± 0.01	0.35^{a} ± 0.01	0.37^{b} ± 0.01	0.38^{b} ± 0.01	ns	*
Wr/Th	0.55 ± 0.01	0.55 ± 0.01	0.55 ± 0.01	0.54 ± 0.01	0.56 ± 0.01	ns	ns
Th/L	0.44 ± 0.01	0.43 ± 0.01	0.43 ± 0.01	0.43 ± 0.01	0.44 ± 0.01	ns	ns
HCW/L (g/cm)	127.6 ± 3.2	122.5 ± 2.9	107.8^{a} ± 2.0	120.8^{b} ± 1.5	143.0^{c} ± 2.3	ns	***
CCW/L (g/cm)	124.6 ± 3.2	119.4 ± 2.9	104.8^{a} ± 2.1	117.5^{b} ± 1.6	139.9^{c} ± 2.3	ns	***

Note: $^{a, b, c}$ means within a row within sex or weight class, not followed by the same superscript differ ($p<0.05$); F = leg length; L = internal carcass length; G = buttock width; Wr = thorax width; Wth = maximum rib width; Th = chest depth; BG = buttock perimeter; PT = thoracic perimeter; A = ribeye width; B = ribeye depth; ribeye area = (A/2) × (B/2) × π; HCW/L and CCW/L = carcasses compactness; G/F = leg compactness; ns = not significant; *$p<0.05$; **$p<0.01$; ***$p<0.001$.

Table 3
Allometric growth coefficients, in relation to the empty body weight, of the measurements and indices determined in the carcasses of Criollo Cordobés kids.

Variables	Sex			
	Males		Females	
	$b \pm$ E.S.	r^2	$b \pm$ E.S.	r^2
F	0.23* ± 0.05	38.32	0.24* ± 0.07	30.76
L	0.25* ± 0.06	39.45	0.32* ± 0.05	58.23
G	0.37* ± 0.05	61.76	0.44* ± 0.06	64.66
Wr	0.38* ± 0.12	27.82	0.46* ± 0.11	37.52
Wth	0.20* ± 0.11	11.06	0.32* ± 0.08	34.57
Th	0.31* ± 0.04	68.87	0.39* ± 0.05	66.91
BG	0.59* ± 0.06	74.45	0.55* ± 0.05	78.51
PT	0.31* ± 0.03	78.67	0.32* ± 0.03	85.01
A	0.56* ± 0.14	37.15	0.45* ± 0.12	33.51
B	0.52* ± 0.18	22.41	0.63* ± 0.23	21.05
Ribeye area	0.87 ± 0.19	85.64	0.87 ± 0.21	84.45
L/G	−0.12* ± 0.06	11.83	−0.12* ± 0.08	6.96
L/PT	−0.07* ± 0.06	5.19	−0.04* ± 0.06	1.89
Th/G	0.08* ± 0.08	1.81	0.08* ± 0.08	3.52
G/F	0.15* ± 0.07	14.88	0.19* ± 0.09	13.32
Wr/Th	0.06* ± 0.12	0.81	0.07* ± 0.09	1.90
Th/L	0.08* ± 0.08	1.1	0.08* ± 0.08	3.52
HCW/L	0.91 ± 0.08	81.88	0.87* ± 0.07	84.35
CCW/L	0.93 ± 0.08	80.80	0.88* ± 0.08	82.19

*Indicates b value different ($p<0.05$) from 1; F = leg length; L = internal carcass length; G = buttock width; Wr = thorax width; Wth = maximum rib width; Th = chest depth; BG = buttock perimeter; PT = thoracic perimeter; A = ribeye width; B = ribeye depth; ribeye area = $(A/2) \times (B/2) \times \pi$; HCW/L and CCW/L = carcasses compactness; G/F = leg compactness.

Abad, Lanari, & Bidinost, 2008). The comparisons with other studies (Manfredini et al., 1988; Colomer-Rocher et al., 1992; Peña et al., 1994b, 2007; Marichal et al., 2003) is difficult due to differences in weight at slaughter and mature size of breed used. Kid gender affected ($p<0.05$) ribeye width and L/PT index, and carcass measures increased ($p<0.05$) and indices improved ($p<0.05$), except L/PT, Th/G, Wr/Th and Th/L, with weight at slaughter. In goats, as the carcasses become heavier, width measurements increased more rapidly than length measures, thus the leg and carcass compactness indices are improved. In general, these results support the findings of Manfredini et al. (1988), Marichal et al. (2003) and Peña et al. (2007).

In general, the allometric coefficients (Table 3) indicate an early development for carcass measurements and indices, except carcass compactness which has an isometric development or not different from 1.0. These results, agree with those of Peña, Gutiérrez, Herrera, and Rodero (1994a) in Florida kids slaughtered at 7–15 kg live weight, which show a trend towards more compact carcasses. There were no differences ($p>0.05$) among sexes.

3.3. Carcass evaluation

Sex and slaughter weight influenced ($p<0.05$) carcass fatness (Table 4). The mean scores for subcutaneous fatness were higher for females than males, and in heavier kids than lighter kids, in partial agreement with Peña et al. (1994a), who found a significant effect of slaughter weight but not of sex.

Sex also showed an effect ($p<0.05$) on the level of internal fat, which was higher in females than in males, while there were no differences between weight groups. This contrasts with the results obtained by Peña et al. (1994b), who found a significant difference between weights but not between sexes.

The subcutaneous fat colour was scored as cream in most kids (67% males and 74% females), darker than those noted by Fehr, Bas, and Schimidely (1986) and Colomer-Rocher, Delfa, and Echiguer (1989) in Alpine and Murciano-Granadina breeds. There were no significant differences between slaughter weights. In contrast, Peña et al. (2007) indicate that the subcutaneous fat colour changes from white to cream with increases in slaughter weight from 8 to 15 kg of liveweight.

The subjective meat colour was mainly assessed as pale in both males and females, scores which were lower to those obtained by Colomer-Rocher et al. (1989) and Peña et al. (2007) in Murciano-Granadina and Florida goat breeds. Slaughter weight influenced ($p<0.05$) the subjective meat colour: group I displayed a higher ($p<0.05$) proportion of carcasses classified as pale colour (63%) and group III displayed a greater ($p<0.05$) percentage of carcass classified as pink (86%).

3.4. Carcass traits

The percentage contribution of fifth quarter and various non-carcass components (Table 5) were similar to those reported for Creole kids (Pérez et al., 2001, Canary Caprine kids (Argüello et al., 2007) and Florida kids (Peña et al., 2007) at similar liveweight (8–15 kg), but different than those obtained by Gallo et al. (1996) in Creole kids slaughtered at higher weight/age (18 kg and 4–6 months). In the present study, the contribution of non-carcass components as a percentage of the empty body weight represented between 40–43%, with no differences ($p>0.05$) among sexes, except for fat depots, in agreement with Peña et al. (2007). The fifth quarter, percentage of EBW, and percentage of subproducts decreased with the increase in slaughter weight, while the

Table 4
Mean scores of visual carcass evaluation and percentage of carcasses in each class from Criollo Cordobés kids.

	Sex				Weight				
	Males	Females	X^2	P	Group I	Group II	Group III	X^2	P
Subcutaneous fatness	2.16	2.56		*	1.93	2.26	2.80		***
Low	23.3%		8.8	0.047	12.5%	9.7%	13.6%	26.1	0.001
Slight	46.7%	60.0%			81.3%	70.7%	13.6%		
Medium	20.0%	26.7%			6.2%	14.1%	45.6%		
High	10.0%	10.0%				5.5%	22.7%		
Very high		3.3%					4.5%		
Internal fatness	1.47	2.01		**	1.63	1.78	1.69		ns
Low	56.7%	23.3%	10.7	0.005	50.0%	34.8%	38.1	2.2	0.692
Medium	40.0%	46.7%			37.5%	52.2%	38.1		
High	3.3%	30.0%			12.5%	13.0%	23.8		
Subcutaneous fat colour	1.67	1.93		ns	1.81	1.91	1.71		ns
White	33.3%	23.3%	4.9	0.085	18.8%	13.0%	38.1%	5.0	0.283
Cream	66.7%	73.4%			82.2%	82.6%	57.1%		
Yellow		3.3%				4.4%	4.8%		
Muscle colour	1.67	1.87		ns	1.38	1.87	1.95		**
Pale	33.3%	20.0%	4.5	0.092	62.5%	17.4%	9.5%	14.9	0.005
Pink	66.7%	73.3%			37.5%	78.3%	85.7		
Red		6.7%				4.3%	4.8%		

ns = not significant; ** $p<0.01$; *** $p<0.001$.

Table 5
Least-squares means (±S.E.) of non-carcass components (% on empty body weight) of Criollo Cordobés kids.

	Sex		Weight at slaughtering			Effects	
	Males	Females	Group I	Group II	Group III	Sex	Weight
Non-carcass components	41.73 ± 0.36	42.08 ± 0.40	43.37^{a} ± 0.47	41.68^{b} ± 0.37	40.37^{c} ± 0.37	ns	***
Subproducts	26.29 ± 0.31	26.79 ± 0.18	27.44^{a} ± 0.27	26.62^{a} ± 025	25.77^{b} ± 0.31	ns	**
Visceral organs	6.11 ± 0.09	5.90 ± 0.10	6.16 ± 0.13	5.96 ± 0.10	5.93 ± 0.13	ns	ns
Stomach	8.30 ± 0.21	7.94 ± 0.17	8.75^{a} ± 0.28	8.11$^{a\ b}$ ± 0.20	7.65^{b} ± 0.18	ns	*
Fat depots	2.76^{a} ± 0.20	1.94^{b} ± 0.07	2.43 ± 0.20	2.19 ± 0.16	2.47 ± 0.24	***	ns
Pericardic fat	0.09 ± 0.004	0.09 ± 0.005	0.08^{ab} ± 0.01	0.08^{a} ± 0.01	0.01^{b} ± 0.01	ns	*
Omental fat	1.27^{a} ± 0.13	0.68^{b} ± 0.05	0.94 ± 0.12	0.88 ± 0.11	1.09 ± 0.17	***	ns
Mesentéric fat	1.41^{a} ± 0.09	1.18^{b} ± 0.04	1.39 ± 0.09	1.23 ± 0.07	1.28 ± 0.09	**	ns

Note: $^{a,\ b,\ c}$ means within a row within sex or weight class, not followed by the same superscript differ ($p<0.05$); subproducts = blood + skin + feet + head.
Visceral organs = lungs + trachea + heart + liver + spleen; stomach = digestive tract.
ns = not significant; *$p<0.05$; **$p<0.01$; ***$p<0.001$.

Table 6
Allometric growth coefficients, in relation to the empty body weight, of the carcass weight and the non-carcass components in Criollo Cordobés kids.

	Sex			
	Males		Females	
	b ± E.S.	r^2	b ± E.S.	r^2
Cold carcass weight	1.17* ± 0.03	96.08	1.21* ± 0.02	97.87
Hot carcass weight	1.19* ± 0.03a	96.01	1.33* ± 0.04b	97.88
Non-carcass components	0.87* ± 0.03	95.46	0.82* ± 0.02	89.75
Subproducts	0.84* ± 0.04a	93.26	0.68* ± 0.07b	78.19
Visceral organs	0.89 ± 0.14	59.62	0.98 ± 0.11	72.41
Stomach	0.66* ± 0.15	40.45	0.67* ± 0.18	33.81
Fat depots	1.31 ± 0.30	40.51	1.23 ± 0.52	16.46
Pericardic fat	1.59 ± 0.48	27.63	1.12 ± 0.48	16.11
Omental fat	2.40* ± 0.86	21.73	1.64 ± 0.82	12.57
Mesentéric fat	1.01 ± 0.24	37.98	0.64 ± 0.46	6.40

*Indicates b value different ($p<0.05$) from 1; values with different letters are significantly ($p<0.05$) different within rows.
Subproducts = blood + skin + feet + head; visceral organs = lungs + trachea + heart + liver + spleen; stomach = digestive tract.

percentage of visceral organs and fat depots did not change ($p>0.05$). In contrast, Marichal et al. (2003) reported a significant increase in the contribution of gastro-intestinal tract as a percentage of the empty body weight; the different diets used in those studies (milk vs. milk + concentrate) may have been the main reason for these differences.

Trends in the variation of percentage for the fifth quarter with increasing slaughter weight reported in the presented study (Table 5) were previously observed by Manfredini et al. (1988) and Peña et al. (2007). Growth coefficients for carcass weight (Table 6) were significantly higher than 1.0, whereas in the remaining non-carcass components the allometric coefficients were lower than one, except for visceral organs and fat depots. Similar patterns of growth coefficients have been reported by Fehr et al. (1986), Dhanda et al. (2003a,b), Marichal et al. (2003). Growth coefficients for hot carcass weight and subproducts were significantly higher and lower, respectively, for males than for females.

3.5. Carcass joints

The percentages of primal cuts of half-carcasses are presented in Table 7. The proportions of joint were similar to those reported (Gallo et al., 1996; Marichal et al., 2003; Argüello et al., 2007; Peña et al., 2007) in kids of different goat breeds slaughtered at 8–15 kg liveweight. Also these percentages were of the same order as those obtained by Zimerman et al. (2008) in Neuquen Criollo kids slaughtered at 3 months of age (32% for hind leg, 22% for shoulder, 24% for ribs, 10% for neck and 11% for flank). According to proportion of valuable cuts, the carcasses obtained in this experiment represented very good composition.

There were no differences ($p>0.05$) among slaughter weights, in agreement with Pérez et al. (2001) and Argüello et al. (2007). On the contrary, Colomer-Rocher et al. (1992) found differences when the slaughter weight range is greater. Diet and slaughter weight may be the main causes of the differences with the results obtained by Peña et al. (2007) and Zimerman et al. (2008), who found a significant increase in the percentages of some primal cuts when weight at slaughter increased. The joints constituted a similar proportion of the carcass in males and females, except for the pelvic-renal fat, lower in males.

The analysis of allometry coefficients of the carcass cuts (Table 8) displayed results similar to those previously outlined above: little variation in the percentage of joint with increasing carcass weight and/or slaughter weight.

Subcutaneous fat is deposited differently in goats than in the other red-meat species. The external fat is usually deposited behind the shoulder and over the ribs. This deposition manifests itself with age/

Table 7
Left-half-carcass weight (kg) and percentage contribution, in relation to half-carcass weight, of primal cuts (least-squares means ± S.E.) of carcasses from Criollo Cordobés kids.

	Sex		Weight at slaughtering			Effects	
	Males	Females	Group I	Group II	Group III	Sex	Weight
Left side weight	2.83 ± 0.1	2.77 ± 0.1	2.26^{a} ± 0.4	2.71^{b} ± 0.4	3.28^{c} ± 0.7	ns	***
Leg (%)	32.2 ± 0.3	32.2 ± 0.3	32.1 ± 0.4	32.3 ± 0.3	32.1 ± 0.3	ns	ns
Shoulder (%)	21.4 ± 0.2	20.9 ± 0.2	21.5 ± 0.3	21.1 ± 0.2	21.0 ± 0.3	ns	ns
Ribs (%)	22.6 ± 0.3	22.8 ± 0.3	22.7 ± 0.4	22.9 ± 0.3	22.5 ± 0.3	ns	ns
Neck (%)	9.5 ± 0.2	9.1 ± 0.2	9.0 ± 0.3	9.5 ± 0.3	9.2 ± 0.3	ns	ns
Flank (%)	10.4 ± 0.2	10.3 ± 0.2	10.4 ± 0.3	10.3 ± 0.2	10.4 ± 0.3	ns	ns
By categories							
Extra	57.8^{a} ± 0.3	54.9^{b} ± 0.3	54.8 ± 0.4	55.0 ± 0.4	54.8 ± 0.5	*	ns
First	21.4 ± 0.2	20.9 ± 0.2	21.3 ± 0.3	21.1 ± 0.3	21.2 ± 0.3	ns	ns
Second	19.7 ± 0.3	19.5 ± 0.3	19.4 ± 0.4	20.0 ± 0.3	19.4 ± 0.4	ns	ns

Note: $^{a,\ b,\ c}$ means within a row within sex or weight class, not followed by the same superscript differ ($p<0.05$); ns = not significant; *$p<0.05$; ***$p<0.001$.
Extra = leg + ribs; first = shoulder; second = neck + flank.

Table 8
Allometric growth coefficients, in relation to carcass weight, of the cuts of the Criollo Cordobés kids carcasses.

	Sex			
	Males		Females	
	b ± E.S.	r^2	b ± E.S.	r^2
Leg	0.97 ± 0.05	93.07	0.91 ± 0.05	92.94
Shoulder	0.89 ± 0.06	88.81	0.87 ± 0.01	90.56
Ribs	0.96 ± 0.09	81.86	1.14 ± 0.10	82.22
Neck	0.93 ± 0.13	62.72	1.19 ± 0.13	76.24
Flank	0.90 ± 0.15	55.30	1.12 ± 0.15	69.48

Table 10
Allometric growth coefficients, in relation to carcass weight, of the dissected tissues from shoulder cuts from Criollo Cordobés kids.

	Sex			
	Males		Females	
	b ± E.S.	r^2	b ± E.S.	r^2
Muscle	1.08 ± 0.02	98.56	1.09 ± 0.31	97.73
Bone	0.96 ± 0.09	81.64	0.78* ± 0.05	89.06
Dissectible fat	1.30 ± 0.61	0.49	1.29 ± 0.50	19.38
Other tissues	0.11* ± 0.42	0.25	0.86 ± 0.38	15.40

*Indicates b value different ($p<0.05$) from 1.

weight. This may be the main reason for the differences found by Peña et al. (2007), who recorded higher allometric coefficients for rib (1.18) and flank (1.16). On the other hand, Colomer-Rocher et al. (1992) recorded growth coefficients for leg and shoulder significantly below 1.0, and higher than 1.0 for ribs and flanks.

3.6. Tissue composition: shoulder cut

Carcass dissection into fat, lean and bone is the best method for evaluation of carcass composition, but it is very expensive. Therefore, many researchers have suggested the use of the half-carcass dissection (Colomer-Rocher et al., 1987), shoulder joint dissection (Argüello, Capote, Ginés, & López, 2001) or other primal cuts (Dhanda et al., 2003a,b), which has no significant reduction in precision. In our study, we chose the shoulder dissection because it can be easily disjointed and it is a good predictor of carcass tissue composition, although not the best (Argüello et al., 2001) (Table 9).

Remarkably, the percentage of muscle in the shoulder was rather high, and the percentage fat low when compared to the results reported (55–59% for muscle and 8–16% for fat) by others (Gallo et al., 1996; Marichal et al., 2003; Todaro et al., 2004; Peña et al., 2007; Zimerman et al., 2008) in different breeds, feeding systems and slaughter weight. The low percentage of fat could be explained by the low nutritional level of the diets of the goats and therefore their kids. We find more similarities with the results recorded by Fehr et al. (1976), Dhanda et al. (1999, 2003a,b), and Marinova et al. (2001), who recorded percentages of 65–68% for muscle and 4–8% for fat. One of the reasons for these differences in tissue composition may be the joint of reference. Gallo et al. (1996) and Zimerman et al. (2008) recorded the percentages of each tissue of primal cuts, and found that the leg and shoulder had the highest percentage of muscle and the lowest percentage of fat. Another reason may be the slaughter weight and diet: high weight vs. low weight and high-energy vs. low-energy diets alter the composition tissue. Marichal et al. (2003), Peña et al. (2007) and Zimerman et al. (2008), among other authors, found an increase in the percentage of carcass fat (8% to 16%) with increased slaughter weight (6 to 25 kg). On the other hand, Fehr et al. (1976) obtained a higher level of carcass fat when diet energy was increased (5% to 7%). Genotype may be another cause for the differences observed in the carcass tissue composition. Carcasses of the same weight produced from different goat breeds are expected to differ in dissectible tissue composition. Comparing goats of different mature body size at the same weight may indicate differences which are related to the stages of maturity rather than breed *per se* (Mahgoub, & Lu, 1998; Dhanda et al., 2003a,b) (Table 10).

As has been noted by some authors (Peña et al., 2007; Zimerman et al., 2008), development of subcutaneous fat is slow in goats. To compare the content between internal carcass fat and fat dissected out of the shoulder, we recorded a ratio of 10 to 1.

There were significant ($p<0.05$) variations between sexes in the percentage of muscle, bone and fat in the shoulder cut. Carcasses from males had significantly higher muscle and bone contents and M/F ratio, lower fat content and M/B ratio than females. These results are in disagreement with those obtained in Saanen kids of 10 kg liveweight by Colomer-Rocher et al. (1992): carcass of the females had a higher content of muscle and similar of dissectible fat.

Despite the higher assessment of subjective subcutaneous fatness, there were no differences ($p>0.05$) among slaughter weight in percentage of muscle, bone, fat, remainder and muscle/bone index (Table 4), while Colomer-Rocher et al. (1992) noted a decrease of bone percentage and an increase of muscle/bone ratio with increasing carcass weight. In the present study, the muscle/fat ratio was higher in the heavier kids.

The mean values of muscle/bone and muscle/fat ratios observed in the present study were greater than the ratios (1.8–2.6 and 3–6.8) recorded in other works (Marichal et al., 2003; Peña et al., 2007). However, they used different dissection techniques (shoulder vs. carcass).

In the present study, all tissues showed an isometric development, except for bone in female which showed an allometric coefficient lower than 1.0. In contrast, Colomer-Rocher et al. (1992) and Peña et al. (2007), among others authors, found increases in fat proportion and decreases in bone proportions with increasing carcass/joint weight.

3.7. Multivariate analysis

To asses carcass quality several related traits are considered which were analysed using various multivariate statistical methodologies: principal component analysis and discriminant analysis.

Table 11 displays the correlation coefficients (r) between the major variables for carcass quality. There are significant correlations between

Table 9
Tissue composition of the shoulder from Criollo Cordobés kids according sex and weight at slaughtering (least-squares means ± S.E.).

	Sex		Weight at slaughtering			Effects	
	Males	Females	Group I	Group II	Group III	Sex	Weight
Muscle	$67.7^a \pm 0.4$	$66.4^b \pm 0.4$	67.4 ± 0.5	68.0 ± 0.5	68.6 ± 0.4	*	ns
Bone	$26.9^a \pm 0.3$	$24.4^b \pm 0.3$	25.9 ± 0.4	25.6 ± 0.3	25.6 ± 0.3	**	ns
Dissectible fat	$3.7^a \pm 0.3$	$6.2^b \pm 0.2$	4.7 ± 0.4	4.5 ± 0.3	3.9 ± 0.3	*	ns
Other tissues	1.3 ± 0.2	1.7 ± 0.1	1.5 ± 0.2	1.6 ± 0.1	1.9 ± 0.2	ns	ns
Muscle/fat	$18.6^a \pm 0.3$	$13.0^b \pm 0.3$	$14.3^a \pm 0.2$	$15.2^b \pm 0.2$	$17.6^c \pm 0.3$	*	***
Muscle/bone	$2.6^a \pm 0.1$	$2.8^b \pm 0.1$	2.6 ± 0.1	2.7 ± 0.1	2.7 ± 0.1	*	ns

Note: $^{a, b, c}$ means within a row within sex or weight class, not followed by the same superscript differ ($p<0.05$).
ns = not significant; *$p<0.05$; **$p<0.01$; ***$p<0.001$.

Table 11
Correlations coefficients (r) between carcass quality measurements.

	EBW	HCW	DP1	DP2	DP3	DP4	Int. fat	CE	CF	CS	M	B	F	M/F	M/B	L	G/F	HCW/L	S. F
HCW	**0.98**																		
DP1	**0.57**	**0.68**																	
DP2	**0.58**	**0.74**	**0.81**																
DP3	**0.59**	**0.69**	**0.98**	**0.79**															
DP4	**0.60**	**0.74**	**0.75**	**0.96**	**0.80**														
Int. fat	0.05	0.07	−0.06	0.07	−0.02	0.13													
CE	−0.08	−0.07	0.19	0.03	0.15	−0.03	**−0.46**												
CF	−0.22	**−0.26**	**−0.34**	−0.31	**−0.36**	**−0.33**	**−0.51**	0.21											
CS	0.07	0.05	−0.06	−0.01	−0.04	0.02	**0.37**	**−0.31**	**−0.42**										
M	0.25	**0.33**	**0.42**	**0.49**	**0.41**	**0.47**	−0.12	0.02	−0.09	−0.14									
B	−0.14	−0.14	−0.12	−0.10	−0.11	−0.08	−0.21	−0.07	0.02	−0.03	**−0.26**								
F	−0.11	−0.11	−0.09	−0.11	−0.07	−0.08	**0.51**	0.04	−0.20	0.24	**−0.32**	**−0.39**							
M/F	0.18	0.19	0.18	0.18	0.17	0.15	**−0.42**	−0.10	0.19	−0.23	**0.33**	**0.32**	**−0.94**						
M/B	0.22	0.25	**0.28**	**0.28**	**0.27**	**0.26**	0.11	0.08	−0.06	−0.02	**0.58**	**−0.93**	0.17	−0.11					
L	**0.59**	**0.59**	**0.37**	**0.40**	**0.33**	**0.34**	−0.00	0.18	**−0.33**	0.13	0.19	−0.22	0.07	−0.10	**0.26**				
G/F	0.23	0.21	0.16	0.09	0.16	0.09	**−0.29**	0.16	0.11	−0.10	0.06	−0.05	−0.24	0.22	0.07	0.21			
HCW/L	**0.91**	**0.93**	**0.64**	**0.70**	**0.68**	**0.74**	0.06	−0.16	−0.16	0.00	**0.32**	−0.06	−0.18	**0.29**	0.18	**0.27**	0.16		
Subct. fatness	**0.46**	**0.46**	0.18	**0.30**	0.22	**0.37**	**0.37**	**−0.29**	−0.13	−0.02	0.20	**−0.27**	0.06	0.00	**0.28**	0.18	0.01	**0.47**	
Int. fatness	0.21	0.21	−0.01	0.11	0.03	0.17	**0.67**	**−0.51**	**−0.43**	**0.26**	0.05	−0.17	**0.31**	−0.25	0.13	0.10	−0.08	0.20	**0.59**

EBW = Empty body weight; DP1 = HCW × 100/; DP2 = HCW × 100/EBW; DP3 = CCW × 100/slaughter weight; DP4 = CCW × 100/EBW; Int. fat: = %(pericardic fat + omental fat + mesenteric fat) × 100/EBW; CE (extra category) = (ribs weight + leg weight) × 100/left-carcass weight; CF = (shoulder weight) × 100/left-carcass weight; CS = (neck weight + flank weight) × 100/left-carcass weight; M = (muscle shoulder weight) × 100/shoulder weight; B = (bone shoulder weight) × 100/shoulder weight; F = (fat shoulder weight) × 100/shoulder weight; M/F = muscle shoulder/fat shoulder; M/B = muscle shoulder/bone shoulder; L = carcass length, HCW/L = carcass compactness; Subct. fatness = visual assessment of subcutaneous fatness; Int. fatness = visual assessment of perinephric fat.
Numbers in bold indicate significant differences ($p < 0.05$).

several variables. The empty body weight and dressing percentages are significantly correlated among them and with the subcutaneous fatness score and carcass conformation, and the muscle percentage. The highest correlation coefficient is between carcass weight and carcass compactness. These results agreed with those recorded by Marichal et al. (2003), Cañeque et al. (2004), and Santos et al. (2007), who reported that carcass conformation was influenced by fatness. Other interesting correlation coefficients are: carcass conformation and muscle shoulder proportion ($r = 0.32$), subcutaneous fatness and extra joints ($r = -0.29$), internal fatness and joints extra ($r = -0.46$) and first joints ($r = -0.51$).

Based on the carcass characteristics, we performed a discriminant analysis to determine if it is possible to discriminate kids based on sex, carcass weight, carcass conformation and carcass fatness, on the basis of objectives or subjective variables, easily assessed at the slaughterhouse, and to determine the carcass quality. After a prior analysis, carcasses were grouped according to HCW (≤4.5 kg; >4.5 kg ≤ 5.5 kg; >5.5 kg ≤ 6.5 kg, and >6.5 kg), carcass conformation (poor: ≤105 g/cm; slight: >105 g/cm ≤ 130 g/cm; average: >130 g/cm ≤ 145 g/cm; high: >145 g/cm) subcutaneous fatness (low; slight, medium, high and very high), and for internal fatness (low, medium and high). The weight and conformation of the carcases were variables with a high level of discrimination, and thus useful in the classification of carcasses for quality and price, while the degree of discrimination by subcutaneous fatness and internal fatness is lower. These results allow defining four categories (<4.5 kg; ≥4.5 kg < 5.5 kg; ≥5.5 kg < 6.5 kg; ≥6.5 kg) and market prices can be established on the basis of this classification.

The results of the PC analysis are presented in Table 12. The first six PCs explain about 85% of the total variance for carcass quality; which is similar to the results obtained by Cañeque et al. (2004) in lambs, and Santos, Silva, Silvestre, Silva, and Azevedo (2008) in kids.

The first PC is characterized by body and carcass weights, dressing percentages, and the subcutaneous fatness and muscle proportion of the shoulder (Fig. 1). The second PC is characterized by fatness (G.I., GI, and F), located on the top in the loading plot (Fig. 1) and by M/F ratio, located opposite to the above variables. Similar results were recorder by Santos et al. (2008). The % extra joints, % bone shoulder and M/B ratio are important for the third PC. All variables studied had

Table 12
Results from principal component analysis for the six principal components of the carcass quality measurements.

Component	Eingenvalue	Portion of variance (%)	Cumulative variance (%)
1	4.32	30.15	30.15
2	2.28	18.90	49.05
3	2.22	13.88	62.93
4	1.62	10.10	73.03
5	1.12	6.54	79.57
6	0.89	5.85	85.42

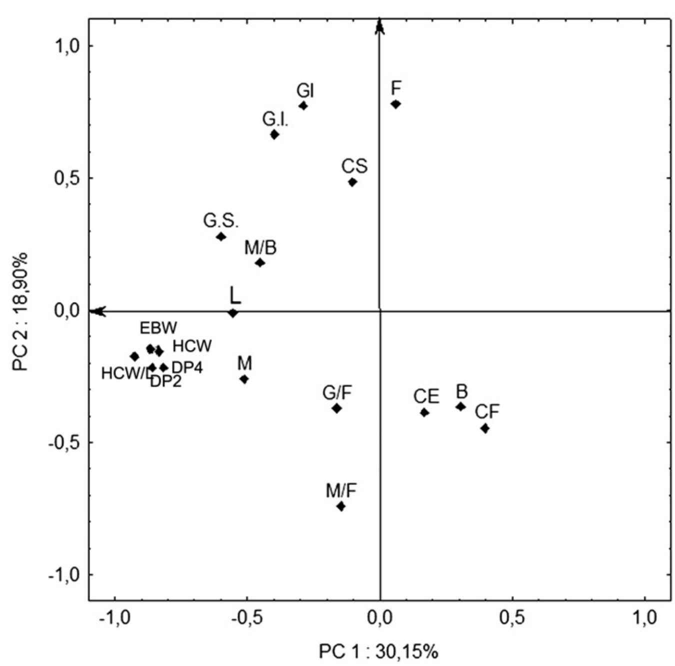

Fig. 1. Projection of the carcass quality measurements in the plane defined by the first two principal components (PCs). Abbreviations: HCW = hot carcass weight; EBW = empty body weight; DP2 = HCW × 100/EBW; DP4 = CCW × 100/EBW; CE = class extra; CF = class first; CS = class second; M = % muscle shoulder; B = % bone shoulder; F = % fat shoulder; M/B = muscle/bone; M/F = muscle/fat; GI = internal fat weight × 100/EBW; L = leg length; G/F = leg compactness; HCW/L = carcass compactness; G.I. = internal fat score; G.S. = subcutaneous fat score.

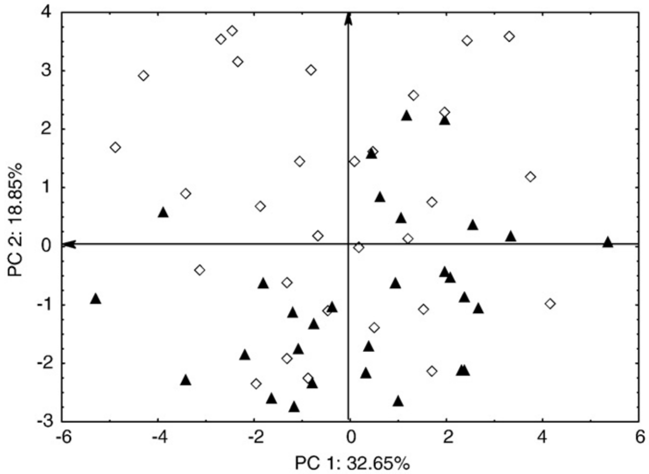

Fig. 2. Projection of carcass quality data of the two sexes studied in the plane defined by two principal components (PCs). Abbreviations: ▲ = female; ◊ = male;

similar proportions in the fourth PC, although % muscle in the shoulder and leg length had the highest negative and positive values, respectively. Ultimately, the proportions of all the variables studied were similar with respect to PCs fifth and sixth, and these variables are placed near both PCs, which shows the low importance in this PC.

Fig. 2 shows the projection of the carcass quality data in the first two PCs of the two sexes. Male kids are predominantly located along the bottom side of the graph, where the M/F and G/F ratios, CE, CF and B variables lie. The females are located on the top side, where the shoulder fat, subcutaneous and internal fatness, in no defined set of points are recorded, in agreement with Santos et al. (2008).

As reported by Cañeque et al. (2004), the measurements related to carcass conformation (hot carcass weight, carcass yield, carcass and leg indexes) and muscle of shoulder are placed 180° from the bone and extra joint and first proportions indicating a negative correlation among these variables. On the other hand, all the fat measurements are positively correlated since they are located in the same quadrant.

Fig. 3 shows the projection of the carcass quality data in the first two PCs of the four hot carcass weights studied. Kids with a hot carcass weight lower than 4.5 kg are located on the top and right side of the graph. The kids with HCW higher than 6.5 kg lie on the left side of the figure, where dressing percentages, muscle percentage, and G/F and M/B ratios lay. With the increase in the carcass weight, kids move to the left of the graph. This results show that dressing percentages and muscle content increases with age/weight. Similar trends were recorder by Marichal et al. (2003) and Santos et al. (2008) in kids of various genotypes and slaughtered at 6–25 kg and 7–13 kg, respectively, who reported that the carcass conformation and fatness score improves with the carcass weight increased (Fig. 4).

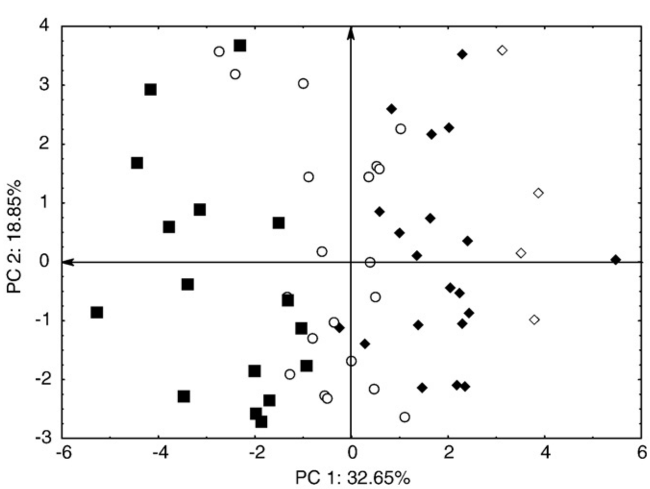

Fig. 3. Projection of carcass quality data of four group of hot carcass weight studied in the plane defined by two principal components (PCs). Abbreviations: ◊ = ≤4.5 kg; ▲ = >4.5 kg ≤ 5.5 kg; □ = >5.5 kg ≤ 6.5 kg; ● = >6.5 kg.

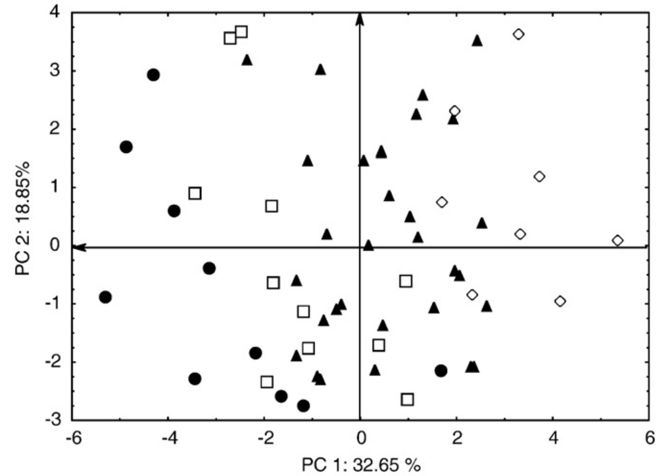

Fig. 4. Projection of carcass quality data of four groups of carcass conformation (HCW/L) studied in the plane defined by two principal components (PCs). Abbreviations: ◊ = poor (≤105 g/cm); ▲ = slight (>105 g/cm ≤ 130 g/cm); □ = average (>130 g/cm ≤ 145 g/cm); ● = high (>145 g/cm).

4. Conclusion

Carcasses of Criollo Cordobés kids, at slaughter weights established in this study, showed an acceptable conformation and colour of muscle and fat, a good level of fat and a high muscle content.

Male and female kids of Criollo Cordobés genotype slaughtered at the same live weight are similar in terms of the carcass dressing, except for the fat content. Furthermore, the results from this study show that increasing slaughtering weight increased (improved) carcass and yield indices.

Multivariate analyses showed distinct groups for carcass quality according to carcass weight and carcass conformation. Therefore we can establish different prices for these variables.

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