

Development of the Morphostructure and Meat Value in Chilota Lambs

Desarrollo de la Morfoestructura y el Valor Carnicero en Corderos Chilotes

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SUMMARY: Chilota sheep are typical of the Chiloé archipelago in southern Chile. The objectives of this study were: 1) To describe the development of the morphostructure of Chilota lambs in their first months of life using some variables that determine lamb meat value (zoometric traits and body weight) and 2) To determine the optimum slaughter age. Measurements were taken from 12 male single-born lambs. Body weight, Withers height; Perimeter of thorax, Chest depth, Shoulder point width and Body length were measured in each animal. The first measurements were taken at 7 days old, and the rest at 37, 67, 97, 127, 157 and 187 days old. The body weight variables and zoometric traits developed allometrically throughout the growth phase. The correlation coefficient between all the traits was very high, varying between 0.91 and 0.98. The zoometric variable that best predicted body weight was Perimeter of thorax ($r^2=0.93$), which was fully developed in 90% of the animals at 97 days old. Maximum growth was recorded in all the studied variables during the first control month, days 7-37, but then it decreased gradually. This decrease was moderate until day 127, becoming very low from then on until end of the study. The optimum age for slaughtering fattened lambs is approximately four months, as from day 127 the daily growth rate slows down considerably, to 61.81 g/day, in comparison with the previous stage, which is 220.00 g/day. Therefore, the maintenance of lambs after four months is not productively efficient.

KEY WORDS: Sheep; Postnatal development; Morphology; Body weight.

INTRODUCTION

The Chilota sheep population is typical of the Chiloé archipelago in southern Chile. This breed is not autochthonous in the archipelago, and was possibly first introduced by Spanish conquerors from 1568. Currently, the total estimated population is 40,000 heads (De la Barra *et al.*, 2011). In 2010, Chilota was officially recognised as the first ovine breed in Chile, with a high conservation value as a result of its contribution to the genetic variability of sheep breeds in the country (De la Barra *et al.*, 2010). Also, the first studies carried out on its productive value indicate that it is a very hardy breed with regard to feeding and health (Calderón *et al.*, 2011; Martínez *et al.*, 2010, 2011a) and has potential for milk production (Martínez *et al.*, 2011b). However, the Chilota breed has traditionally been reared for lamb meat production as part of the tourist offer in the Chiloé archipelago. Knowledge of the growth process in the Chilota lamb during its first months of life would be very useful for

determining the optimum slaughter age and taking full advantage of the animal's growth, and eventually, ewe milk production.

The objectives of this study were: 1) To describe the development of the morphostructure of Chilota lambs in their first months of life using some variables that determine lamb meat value (zoometric traits and body weight) and 2) To determine the optimum slaughter age.

MATERIAL AND METHOD

A sample of 12 male Chilota lambs was used in the study. The lambs came from a group of 40 three year-old ewes kept under a common management system from heat

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to weaning at 90 days post partum. The lambs were all the same age, born in single births within 48 hours to ewes with synchronised oestrus. The lambs were separated from their mothers at ninety days old and kept together in natural pasture until 180 days old. The recorded traits were: body weight (BW), perimeter of thorax (PT), chest depth (CD), shoulder point width (SW) and body length (BL). Measurements were taken every month, when the lambs were 7, 37, 67, 97, 127, 157 and 187 days old. These body measurements, related to meat value, had been used in previous studies (Álvarez *et al.*, 2000; Espinace, 2009; Calderón *et al.*, 2009; Bravo & Sepúlveda, 2010; De la Barra *et al.*, 2011). Tape measure, a compass and a skin fold calliper were used to measure the traits. ADG was measured by means of a field scale. Statistical analysis was done with the SAS program and GLM, REG and CORR procedures (SAS, Cary Inc). In the analytical model, the dependent variables were the body measurements and the independent variable was age.

RESULTS AND DISCUSSION

A lamb's body resembles the dimensions of a cylinder where length, width and depth roughly define the volume (Bravo & Sepúlveda; Toro *et al.*, 2010).

Table I shows the basic statistics of body weight and morphological measurements in the lambs. The graph in figure 1 shows how these body traits evolved. All of the body weight and zoometric trait variables can be seen to develop in a similar way. Figure 1 shows how all the traits developed allometrically. The coefficient of correlation between all traits was very high, ranging from 0.91 to 0.98 due to a common underlying factor of variation, which was age. As the evolution of all the variables was closely correlated, an overall analysis of growth for all traits will be carried out later.

The prediction of body weight via linear regression with the body measurements following a forward selection method showed that PT ($r^2=0.93$) was the zoometric measure that best predicted body weight. The next best traits were SW and CD with a partial r^2 of 0.017 and 0.004, respectively, their contribution to the prediction being less important.

The mean monthly growth rate for each trait according to the age of the lamb is shown in Table II. An ANOVA for these characters, with month, 6 levels, as the variation factor, was done to compare monthly growth. The results are shown in Table III.

Table II shows rapid initial growth when the animal was very young, which decreased until it reached the adult stage. Maximum growth was recorded between the first 7-37 days of life and then decreased progressively. This decrease occurred in two or three stages depending on the trait, being moderate until day 127 and then very low until the end of the test.

The results of the ANOVA for all traits can be seen in Table III. There are significant differences between monthly growth, the highest occurring in the youngest stages, particularly from birth to 97 or 127 days depending on the trait being considered.

Significant differences are observed between three stages (a, b and c). The first stage (a) corresponds to the 7-37-day interval, with maximum values for growth, in comparison with the following stages where values were lower, except for BL with maximum growth during the first two months, days 7-67.

The second stage of growth (b) in some variables such as PT and CD lasted a month (days 37-67). In others, namely WH and SW, growth lasted two months (days 37-97) and in others such as BW it lasted 3 months (days 37-

Table I. Descriptive statistics of body weight and morphological traits in Chilota lambs (n=12).

Trait*	Age (d)						
	7	37	67	97	127	157	187
	Mean±SE						
BW (kg)	3.81±0.26	13.36±0.32	19.85±0.58	25.50±0.75	30.20±0.71	31.78±0.66	33.91±0.53
WH (cm)	33.11±0.69	45.13±0.36	52.33±0.37	54.29±0.32	58.32±0.52	58.66±0.50	59.62±0.39
PT (cm)	36.65±1.06	55.58±0.64	65.41±0.91	69.41±0.88	72.05±0.80	74.66±0.74	78.24±0.88
CD (cm)	12.42±0.29	17.58±0.26	20.58±0.23	24.27±0.37	24.45±0.29	24.78±0.41	25.79±0.58
SW (cm)	8.13±0.32	13.37±0.36	16.33±0.48	19.56±0.40	20.79±0.44	21.54±0.47	22.71±0.28
BL (cm)	26.68±0.71	39.58±0.37	51.58±0.64	55.40±0.61	58.41±0.53	59.45±0.31	61.55±0.25

*BW: Body weight; WH: Withers height; PT: Perimeter of thorax; CD: Chest depth; SW: Shoulder point width; BL: Body length.

Table II. Growth of body weight and morphological traits in Chilota lambs (n=12).

Trait*	Age (d)					
	7-37	37-67	67-97	97-127	127-157	157-187
	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE
ADG (g/d)	318.61±15.61 ^a	216.11±14.31 ^b	188.61±9.70 ^b	156.66±19.24 ^b	52.50±8.13 ^c	71.11±19.11 ^c
BW (kg)	9.55±0.47 ^a	6.48±0.43 ^b	5.66±0.29 ^b	4.70±0.58 ^b	1.58±0.24 ^c	2.13±0.57 ^c
WH (cm)	12.02±0.86 ^a	7.20±0.49 ^b	1.96±0.27 ^b	4.03±0.50 ^c	0.34±0.18 ^c	0.96±0.30 ^c
PT (cm)	18.93±1.54 ^a	9.83±0.84 ^b	4.00±0.76 ^c	2.64±0.41 ^c	2.61±0.65 ^c	3.58±0.58 ^c
CD (cm)	5.16±0.47 ^a	3.80±0.43 ^b	1.98±0.29 ^c	0.72±0.24 ^d	0.90±0.21 ^d	0.64±0.54 ^d
SW (cm)	5.24±0.54 ^a	3.00±0.29 ^b	3.69±0.29 ^b	0.18±0.29 ^c	0.33±0.18 ^c	1.01±0.28 ^c
BL (cm)	12.90±0.82 ^a	12.00±0.74 ^a	3.81±0.38 ^b	3.01±0.72 ^b	1.04±0.48 ^c	2.10±0.42 ^c

* ADG: Average daily gain, BW: Body weight; WH: Withers height; PT: Perimeter of thorax; CD: Chest depth; SW: Shoulder width; BL: Body length. a-d, Means in the same row with different superscripts differ (P < 0.05).

Table III. Analysis of variance for the month effect.

Trait *	DF	F value	Pr > F	R ²
BW (kg)	5	43.10	<0.0001	0.76
WH (cm)	5	84.10	<0.0001	0.87
PT (cm)	5	54.70	<0.0001	0.80
CD (cm)	5	29.06	<0.0001	0.69
SW (cm)	5	26.83	<0.0001	0.67
BL (cm)	5	81.73	<0.0001	0.86

*BW: Body weight; WH: Withers height; PT: Perimeter of thorax; CD: Chest depth; SW: Shoulder width; BL: Body length.

127). The growth rate in the third stage (c) was very low, occurring from day 127 (SW and CD) in some, and from day 157 in the rest. As can be seen in Figure 1, all body measurements for the Chilota breed follow a similar pattern of growth, which is rapid in the first month of life, reaching 318 g/d ADG and then slows down, as occurs in other breeds (Abassa *et al.*, 1992), with a very low ADG of 61.81 g/d from day 127.

Another way of measuring growth described in this discussion is by comparing the percentage of the value of

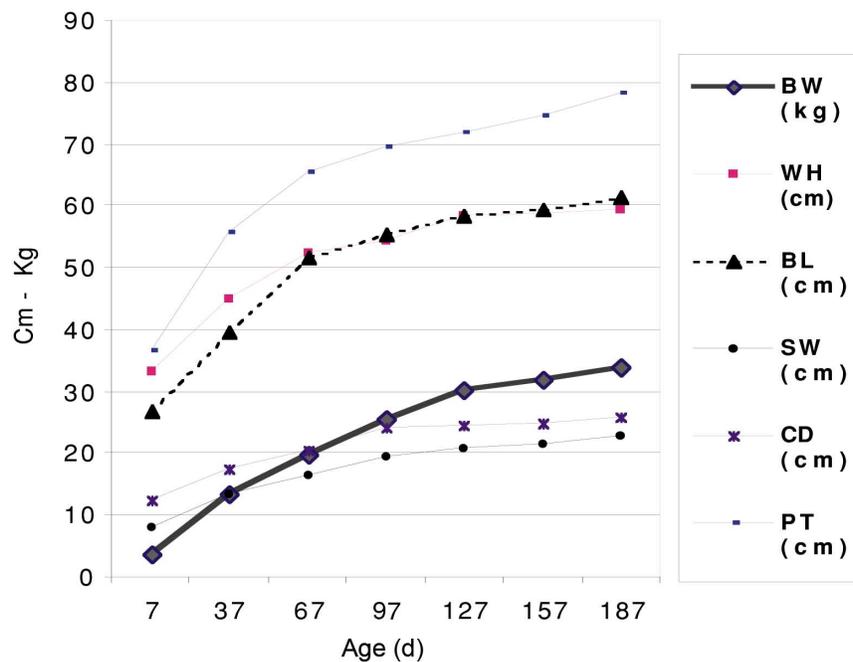


Fig. 1. Monthly evolution of body weight and zoometric traits in Chilota lambs. BW: Body weight; WH: Withers height; BL: Body length; SW: Shoulder width; CD: Chest depth; PT: Perimeter of thorax.

each trait with the value in the adult animal, based on data for Chilota breed published by De la Barra *et al.* (2011).

The growth curve pattern for each measure is very similar, which indicates fairly allometric growth, but it is not identical for all variables. Growth is very rapid for WH and BL; by 127 days they had already reached 97% and 94% of the value corresponding to adult animals, respectively. However, growth in other traits was not so rapid, CD and SD reaching 74% and 77% of the measures for adults, respectively, at 127 days old.

The results are coincident with those for expected development, where structural measurements such as height and length increase first, followed by an increase in measurements associated with fattening traits such as chest and rump width.

Although all the measurements are closely correlated (r between 0.91 and 0.98), when a forward regression was made, the zoometric measurement that best predicted body weight was PT, which is undoubtedly a good estimator of overall body growth. Including other variables in the regression does not improve accuracy. In this sense, PT is closely related to meat value and is the main descriptor of a morphostructure that favours greater meat yield (Herrera *et al.*, 1996).

In the Chilota breed, all of the variables show rapid growth during the first days of life, thoracic perimeter reaching 83% of the measure corresponding to the adult at 67 days, 90% at 97 days and 92% at 127 days. Although morphological development is complete relatively early, development in BW is slightly more delayed, 65% at 127 days. Although a lamb's body is defined by its spatial dimensions (length, height and width), weight and carcass yield, and therefore meat value, are in fact determined by muscular development in the morphostructural matrix (Sañudo, 2008; Sanz *et al.*, 2008; Bravo *et al.*, 2010; Barcelos *et al.*, 2010).

Chilota lambs are normally slaughtered at 150-180 days old, as occurs with other introduced breeds, because they reach their maximum weight at this age (Shrestha *et al.*, 1982, 2007; Stanford *et al.*, 1996; Hammel & Laforest, 1999; Teixeira *et al.*, 2004).

As Chilota lambs mature earlier, they should be slaughtered at 120-150 days, or even before depending on the type of carcass being produced. Miguélez *et al.* (2007), state that in Spanish ovine breeds, slaughter at an early age makes a noticeable difference to the organoleptic quality of lamb meat in comparison with slaughter at a later age. Luaces *et al.* (2007) indicate that in Spanish breeds, the lower the slaughter age, the greater the proportion of muscle and bones,

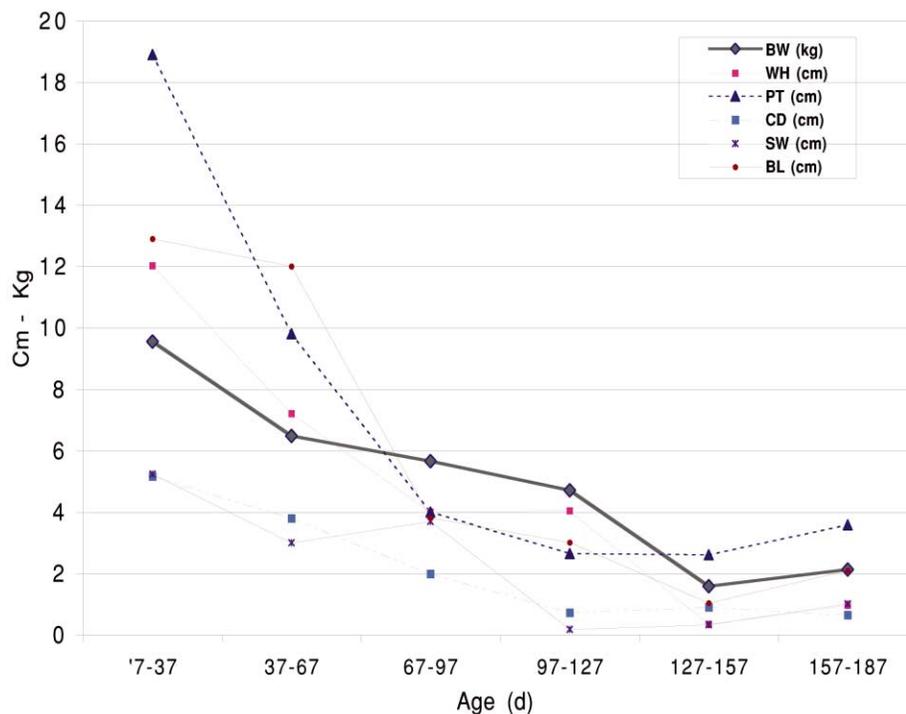


Fig. 2. Monthly growth of body weight and zoometric traits in Chilota lambs. BW: Body weight; WH: Withers height; PT: Perimeter of thorax; CD: Chest depth; SW: Shoulder width; BL: Body length.

whereas the higher the slaughter age the greater the proportion of fat.

Given the rate of growth in Chilota lambs until 67-97 days of age, the production of lambs for early slaughter appears to be an interesting option, as by that age they have reached a considerable size. Also, the meat is good quality and of great commercial value due to having a lower proportion of fat.

On the other hand, if a heavier lamb is required, the ideal slaughter age is approximately 4 months, as the daily growth rate after day 127 is very low, 61.81 g/day, in comparison with 220.00 g/day in the previous stage. Slaughter lambs after 4 months of age is not productive efficient, and could be not economically attractive as costs could exceed any profit generated.

If we consider zoometric variables as well as the growth rate, the conclusions are similar. BL and TP are the relevant defining lamb carcass traits, as well as yield in high value cuts such as the loin (Stanford *et al.*; Capenter & Cockett, 2000; Sañudo). In this study, the results obtained for BL and PT show that at 127 days growth accounts for 94% and 92% of the adult stage, respectively. Any gain after day 127 is low, which is in accordance with the idea of slaughter at approximately 4 months.

SW showed the lowest rate of development, 77%, after 127 days. However, this measurement is not associated with the commercial value of the carcass and is therefore not an important predictor of its economical value. Also, growth in the later stages is associated with larger fat deposits and is not desirable for the commercial value of the carcass.

DE LA BARRA, R.; MARTÍNEZ, M. E.; CALDERÓN, C.; MORALES, R. & DE LA FUENTE, L. F. Desarrollo de la morfoestructura y el valor carnicero en corderos chilotos. *Int. J. Morphol.*, 30(4):1538-1543, 2012.

RESUMEN: La oveja Chilota es una raza típica del archipiélago de Chiloé en el sur de Chile. Se midieron 12 corderos machos nacidos de parto único. En cada animal se midieron el peso corporal, la alzada a la cruz, el perímetro del tórax, diámetro dorso esternal, diámetro bicostal y la longitud corporal. Las primeras mediciones se tomaron a los 7 días de edad, y el resto a los 37, 67, 97, 127, 157 y 187 días de edad. El peso corporal y los rasgos zoométricos se desarrollaron alométricamente a lo largo de la fase de crecimiento. El coeficiente de correlación entre todos los rasgos fue muy elevado, variando entre 0,91 y 0,98. La variable zoométrica mejor predicha por el peso corporal fue el perímetro torácico ($r^2=0,93$), el cual estuvo totalmente desarrollado en el 90% de los animales a los 97 días de edad. El crecimiento máximo fue registrado durante el primer mes de control (días 7-37) para todas las variables estudiadas, pero posteriormente decreció de forma gradual. Este decrecimiento fue moderado hasta el día 127, volviéndose muy lento hacia el final del estudio. La edad óptima para el sacrificio de los corderos es aproximadamente de 4 meses, dado que a partir del día 127 la tasa diaria de crecimiento disminuye considerablemente, a 61,81 g/día, en comparación con la etapa previa, donde esta tasa es de 220,00 g/día. Por lo tanto, el sacrificio de los corderos más allá de los 4 meses de edad no resulta productivamente eficiente.

PALABRAS CLAVE: Ovino; Desarrollo postnatal; Morfología; Peso corporal.

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