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PERFORMANCE AND CARCASS CHARACTERISTICS OF LAMBS WITH THREE SUBCUTANEOUS FAT THICKNESSES IN THE LOIN

Francisco de Assis Fonseca de Macedo[1], Thiago Peres Gualda[1], Alexandre Agostinho Mexia[2], Filipe Gomes de Macedo[3], Franciane Barbieri Dias[1], Natália Holtz Alves Pedroso Mora[1]

[1] UEM
[2] UNEMAT
[3] UNESP
Correspondência: Alexendre Agostinho Mexia: alexandre@unemat.br

ABSTRACT: The objective of this study was to evaluate productive and economic performances and quantitative carcass characteristics of ½Dorper + ½Santa Inês (½D-SI) and purebred Santa Inês (SI) lambs slaughtered with different subcutaneous fat thicknesses (SFT). Thirty-four lambs (16 SI and 18 ½D-SI) were confined and fed a total diet for an average daily weight gain of 0.300 kg. The subcutaneous fat thickness was measured by ultrasound (between the 12th and 13th ribs) and weekly weighing, and the lambs were slaughtered as they reached the pre-established SFT of 2.0, 3.0 and 4.0 mm. Breed group had no effect on productive performance. With regard to SFT, the final body weight was highest in the animals slaughtered with 4.0 mm. The economic evaluation provided an increasing net income with increase in SFT. The commercial and true yields were affected by the SFT at slaughter. For the cuts, the yield of the loin of crossbred animals was higher than that of Santa Inês lambs. The loin measurements showed no difference between breed groups. The lambs slaughtered with 2.0 and 3.0 mm of fat thickness presented the best feed conversion; however, those slaughtered with 4.0 mm of fat thickness had better economic results.
Key Words: Dorper, production costs, Santa Inês, ultrasound

DESEMPENHO E CARACTERÍSTICAS DE CARCAÇA DE CORDEIROS COM TRÊS ESPESSURAS DE GORDURA SUBCUTÂNEA NO LOMBO

RESUMO: O objetivo do trabalho foi avaliar o desempenho produtivo, econômico e características quantitativas da carcaça de cordeiros ½ Dorper ½ Santa Inês (½ D-SI) e Santa Inês puros (SI), abatidos com diferentes espessuras de gordura subcutânea (EGS). Foram utilizados 34 cordeiros, sendo 16 SI e 18 ½ D-SI, mantidos em confinamento, recebendo ração total para ganho de peso médio diário de 0,300 kg. Foram realizadas aferições da EGS por meio de ultrassonografia (entre a 12ª e 13ª costelas) e pesagens semanais, sendo que os abates ocorriam à medida que os cordeiros atingiam a EGS pré-determinada: 2,0; 3,0 e 4,0 mm. Não houve efeito do grupo racial para o desempenho produtivo. Em relação às EGS, observou-se superioridade no peso corporal final dos animais abatidos com 4,0 mm. A avaliação econômica proporcionou renda líquida crescente com aumento da EGS. Os rendimentos comercial e biológico foram influenciados pelas EGS ao abate. Para os cortes, o rendimento do lombo dos animais cruzados foi superior aos Santa Inês. Em relação às medidas no lombo, não houve diferença nestas para o grupo racial. Os cordeiros abatidos com 2,0 e 3,0 mm de espessura de gordura apresentaram melhor conversão alimentar, entretanto, os abatidos com 4,0 mm de espessura de gordura apresentam melhores resultados econômicos.
Palavras-chave: custo de produção, Dorper, Santa Inês, ultrassonografia

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INTRODUCTION

When sheep farmers adequate to the technological rearing system they must aim at achieving muscular precocity and appropriate carcass fat thickness in the marketed animals, seeking to meet both the economic profitability of the activity and the demands of the consumer market. In this scenario of productivity and demand, Lima *et al.* (2012) emphasize the importance of conducting research on this livestock activity in Brazil.

At present the most utilized maternal breed in Brazil for production of lambs intended for slaughter is Santa Inês; this is primarily because these are rustic, year-long polyestrous animals that adapt easily to the management conditions. However, carcasses from lambs of this breed do not possess characteristics equivalent to those of lambs originating from crossings with breeds intended for meat production, as demonstrated in the studies conducted by Garcia *et al.* (2010) and Paim *et al.* (2013).

The use of Dorper lambs in breeding programs may benefit sheep production, because this breed presents traits of rapid weight gain, excellent carcass conformation and adaptability. This fact was observed by Souza *et al.* (2013), who found improvement in carcass conformation, and Amaral *et al.* (2011), who obtained greater net income with Santa Inês, ½Dorper + Santa Inês and ½White Dorper × Santa Inês lambs.

With regard to the intensive rearing system, the time of permanence on concentrate diets may affect the production profitability due to the high production costs, which makes it essential to know the ideal moment for slaughter. In this context, the *in vivo* evaluation of body traits can better indicate the moment for slaughter.

Among the available techniques, the ultrasound stands out for being a practical, painless and precise method that improves the prediction of the body composition in a real-time (Peres et al.,2010) with proven availability and accuracy, especially to measure the loin-eye area and the cover-fat thickness (Nubiato *et al.*, 2013). According to Osório *et al.* (2012), the ideal moment to slaughter the animals should be based on the proportion of fat that suits the consumer.

The amount of external fat on the *longissimus thoracis* muscle at the 13th rib is an important parameter that determines the quality of sheep carcasses. This muscle is of easy measurement, hence why it is preferred for determination of the loin-eye area, defined as an objective measurement to predict the amount of muscle in the carcass (Pinheiro, 2006).

Given the new demands by the consumer market and the possibility of employing proper management and practices in livestock production, the objective of this study was to evaluate productive performance, net income, quantitative carcass characteristics and tissue composition of the *longissimus thoracis* muscle in Santa Inês and ½Dorper + ½Santa Inês lambs slaughtered with 2.0, 3.0 and 4.0 of subcutaneous fat thickness, assed by ultrasound.

MATERIAL AND METHODS

Thirty-four weaned male lambs at approximately 60 days of age, with an average body weight of 21.56 ± 1.34 kg, 16 of which belonged to the Santa Inês (SI) and 18 to the ½Dorper + ½Santa Inês (½DSI) breed groups were used in this experiment. The lambs went through a 15-day period of acclimation to the facilities and experimental diet.

The animals were randomly distributed into individual covered pens with suspended slatted floors. The treatments were defined as the subcutaneous fat thickness in the loin, between the 12th and 13th ribs (2.0, 3.0 and 4.0 mm), evaluated by ultrasound. The animals received water *ad libitum* all through the experimental period, and were fed total mixed and pelletized diet, which was formulated to provide a daily weight gain of 0.30 kg (NRC, 2007). The diet was supplied *ad libitum* once daily in the morning, so as to provide 10% of leftover feed.

The evaluations by ultrasound and weighing were performed weekly. To obtain the subcutaneous fat thickness, a HONDA ultrasound device model HS-1500 VET, with probe of 7.5 MHz, was used. Lambs were manually immobilized and the measured areas were trimmed, with subsequent application of mucilage to improve the contact of the probe with the skin. All measurements were performed by the same technician, on the left side, between the 12th and 13th ribs, 4 cm away from the spine. The pressure of the probe was kept minimal to avoid compression of the fat. After the image was captured, the subcutaneous fat thickness in that area was measured using the electronic pointer of the ultrasound machine.

The chemical composition of the diet supplied to the lambs was analyzed at the Laboratory of Animal Nutrition and Feeding, located in the Department of Animal Science of UEM (Table 1).

Table 1. Chemical composition, percentages and production cost of the diet

Item	Composition (%)	Cost (R$/kg)
Hay of *Stylosanthes* grass cv. Campo Grande	20.00	0.45
Ground corn grain	51.83	0.28
Soybean meal	17.01	0.72
Soybean hulls	5.00	0.55
Molasses	2.00	1.20
Ammonium chloride	2.00	1.30
Sodium bicarbonate	1.00	1.30
Mineral mix [1]	1.00	2.00
Dry matter	87.80	-
Crude protein	16.12	-
Ether extract	2.68	-
Neutral detergent fiber	28.67	-
Acid detergent fiber	14.85	-
Ash	7.48	-
Calcium	0.49	-
Phosphorus	0.37	-
In vitro dry matter digestibility	77.15	-
Total digestible nutrients	75.57	-
Total cost of the diet	99.84	0.66

Prices as of July 2010 in Maringá-PR/Brazil.
[1] Guaranteed levels of the mineral mix per kg: Calcium 220 g, Phosphorus 130 g, Magnesium 25.5 g, Sulfur 24 g, Iron 3,000 mg, Manganese 1,500 mg, Zinc 4,000 mg, Copper 1,200 mg, Cobalt 280 mg, Iodine 260 mg, Selenium 30 mg and Fluorine 300 mg. TDN estimated by the equation (ALDAI *et al.*, 2010): %TDN = 92.20 – (1.12 × ADF).

The cost of acquiring the Santa Inês lambs was R$ 3.50/kg of body weight, and for the crossbred lambs, R$4.00/kg of body weight.

To simplify the procedures and precision of the evaluation, the revenues and costs were projected for a module of 500 animals, respecting the due proportionality of the evaluated lots, in the price search and determination of revenues. Only the direct production costs were considered, such as acquisition of the lambs, expenses with the diet and expenses with labor, since the fixed costs - because they vary with the operational cycle - can be disregarded in view of the objectives of the analyses performed.

After the chemical composition of the diet and the respective price of its ingredients were determined, the average cost of 1 kg of diet supplied to the lambs was calculated, resulting in R$0.66, as demonstrated in Table 1.

For purposes of this evaluation, we considered that a worker with daily dedication of 8 hours would be enough to meet the requirements related to the management of 500 sheep (Table 2).

The price for the sale of carcasses was R$10.00/kg for those of Santa Inês lambs, and R$11.00/kg for those of crossbred animals; these are the prices charged for the acquisition of whole carcasses by the restaurants of the region, obtained from the Association of Sheep Farmers of Maringá (Associação de Criadores de Ovinos da Região de Maringá, Ovinomar).

We evaluated productive performance and the costs and net income for the production of lambs according to the genotypes and fat thicknesses at slaughter. The first evaluation (genotype) was performed to verify the productive potential of the groups and their reflections in the profitability of the process, and the second (fat thickness at slaughter) was to verify the influence of the developmental stage of the subcutaneous fat tissue on the performance and profitability of the production.

Table 2. Payroll and related costs referring to 1.5 monthly minimum wages

1.5 Minimum wage		R$ 765.00
Welfare program	20.00%	R$ 153.00
Occupational accident insurance	2.00%	R$ 15.30
Salário educação (Public education-financing program)	2.50%	R$ 19.12
SESI/SESC	1.50%	R$ 11.47
Senai/Senac	1.00%	R$ 7.65
Sebrae	0.60%	R$ 4.59
Incra	0.20%	R$ 1.53
FGTS	8.50%	R$ 65.02
Total social charges	36.30%	R$ 277.70
Weekly paid rest	18.77%	R$ 143.00
Annual leave	9.03%	R$ 68.85
Year-end vacation benefit	3.61%	R$ 27.61
Holidays/legal leaves	3.97%	R$ 30.37
Maternity/medical leave	1.90%	R$ 14.53
Resignation notice	2.46%	R$ 18.81
13th salary	10.83%	R$ 82.84
Total labor charges	50.57%	R$ 386.86
Ordered monthly expenses		R$ 1,429.56
Proper monthly value for 34 animals		R$ 97.21

As the lambs reached the pre-established fat thicknesses of 2.0, 3.0 and 4.0 at the weekly evaluation by ultrasound, they were slaughtered on the following day after the measurements, irrespective of weight.

After spending 18 hours deprived of solid food, the animals were weighed to determine the slaughter weight, and then stunned by electronarcosis of 220 V for 8 seconds. After bleeding and evisceration, the gastrointestinal tract was emptied so that the empty body weight (EBW) could be determined. This measurement was obtained by subtracting the slaughter weight (SW) from the gastrointestinal content. The carcasses were weighed to determine the cold carcass weight (CCW). Having the weights, the commercial carcass yield (CCY = CCW/SW × 100), true carcass yield (TCY = HCW/EBW × 100) and cooling loss (CL = CCW/HCW × 100) were determined.

The internal carcass length (ICL), rump width (RW) and leg length (LL) were measured to calculate the carcass compactness index (CCI = CCW/ICL) and the leg compactness index (LCI = RW/LL).

The carcasses were sawn lengthwise and each left half-carcass was sectioned into seven commercial cuts: neck, shoulder, breast+flank, false ribs, ribs, loin and leg (Colomer-Rocher & Espejo, 1972). The cuts were weighed individually to obtain the equivalent as percentage in relation to the half-carcass weight.

The loins were then identified, individually vacuum-packed, stored in a freezer at –18 ºC, and subsequently defrosted and dissected to determine the proportions of muscle, fat and bone.

The cross-sectional area of the muscle was drawn onto transparency paper, and subsequently the loin-eye area was determined on computer software AUTOCAD®.

Software SAEG was used for the statistical analyses, considering breed group, subcutaneous fat thickness at slaughter and their interaction. Means were compared by Tukey's test at 5% of significance.

RESULTS AND DISCUSSION

The results for genotypes and subcutaneous fat thickness (2.0, 3.0 and 4.0 mm) are shown in Table 3. Breed group had no effect on the productive performance of the evaluated lambs. This fact might be justified by the good genetics of the maternal herd, which, though not intended for meat like Dorper, has long undergone productive selection. Contrary to these results, Garcia *et al.* (2010) observed differences even in half-blood animals.

Regarding the subcutaneous fat thickness, the final body weight of animals slaughtered with 4.00 was higher by 7.86 and 3.81 kg as compared with the animals slaughtered with 2.0 and 3.0 of fat thickness, respectively. Such behavior is probably attributed to body changes with deposition of the tissues in the carcass as a consequence of maturity.

For the daily weight gain, no difference was observed ($p > 0.05$)

among the fat thicknesses evaluated, possibly because of the chronological and physiological similarity of the experimental animals until the moment of slaughter.

The total weight gain was similar among the animals from treatments 2.0 and 3.0 mm, assuming physiological proximity among the animals, with slow deposition of fat compared with muscle and bone depositions. However, lambs slaughtered with 4.0 of fat thickness presented higher total weight gain, but took 27 and 38 more days in feedlot as compared with the results of 3.0 and 2.0 mm, respectively, which reinforces the idea of the chronology in tissue deposition according to the animal maturity (Cartaxo *et al.* 2008).

Feed intake was different ($p < 0.05$) among the lambs slaughtered with different fat thicknesses, and this result can be explained by the need for greater nutritional uptake of the lambs that showed higher body weight. Also, lambs slaughtered with 2.0 and 3.0 mm of subcutaneous fat thickness had better feed conversion (FC) when compared with those slaughtered with 4.0 mm, because, energetically, it is more costly for the animal to deposit fat than meat.

The increasing production costs are due to the expenses with feeding, which corresponded, on average, to 35% of the total expenses, with higher production costs observed for the animals slaughtered with 4.00 of fat thickness, because they require more time confined to reach the pre-established fat thickness. However, the economic evaluation expressed as absolute values provided increasing net income as the subcutaneous fat thickness at slaughter was increased, and this can be justified by the similarity in average daily gain among the treatments, as also observed by Amaral *et al.* (2011), who worked with lambs slaughtered with 2.0, 2.5 and 3.0 of subcutaneous fat thickness.

For the net income according to breed group, the ½D-SI animals were the highest grossing, with a difference of R$ 9,395.84, i.e., although the total expenses are higher for this group, the superiority was the result of larger quantity of carcass produced coupled to better market sale price.

With regard to the carcass characteristics, no effect of integration was verified ($p > 0.05$) between breed group and fat thickness, and the breed groups did not interfere with CCY (%), TCY (%), CL (kg), CCI (kg/cm) or LCI. Yet, the commercial and true yields were affected ($p < 0.05$) by the fat thicknesses at slaughter, with higher values in both variables at 4.0 mm of thickness, followed by 3.0, and then 2.0 mm. According to Cezar & Souza (2007), regardless of species and sex, as the age or maturity of the animal increases, the carcass yield does likewise.

Table 3. Means and standard deviations for production costs and revenues with Santa Inês (SI) and ½Dorper + ½Santa Inês (½D-SI) lambs slaughtered with different subcutaneous fat thicknesses

Genotype		Fat thickness, mm		
SI	½D-SI	2.0	3.0	4.0
22.30 ± 1.02	21.42 ± 0.96	21.29 ± 1.23	23.64 ± 1.18	20.65 ± 1.23
37.20 ± 0.61	38.22 ± 0.57	33.74 ± 0.73c	37.79 ± 0.70b	41.60 ± 0.73a
17.55 ± 1.60	18.57 ± 0.83	15.56 ± 1.40c	18.43 ± 1.28b	20.19 ± 0.96a
16.62 ± 0.49	17.73 ± 0.46	14.79 ± 0.59b	17.68 ± 0.56a	19.05 ± 0.59a
0.26 ± 0.014	0.29 ± 0.014	0.26 ± 0.017	0.29 ± 0.017	0.27 ± 0.017
14.90 ± 0.94	16. 80 ± 0.89	12.45 ± 1.14b	14.15 ± 1.09b	20.95 ± 1.14a
1.02 ± 0.52	1.11 ± 0.48	0.97 ± 1.62c	1.10 ± 1.60b	1.14 ± 1.62a
3.92 ± 0.23	3.82 ± 0.24	3.73 ± 0.29b	3.79 ± 0.27b	4.22 ± 0.28a
64.06 ± 1.02	62.17 ± 0.97	47.64 ± 1.24c	58.75 ± 1.19b	86.05 ± 1.24a
8,310.00	8,865.00	7,395.00	8,840.00	9,525.00
R$	R$	R$	R$	R$
39,025.00	42,840.00	39,918.75	44,325.00	38,718.75
21,562.59	22,772.87	15,249.56	21,326.25	32,372.00
207.55	201.43	154.35	190.35	279.54
60,795.14	65,814.30	55,322.66	65,841.60	71,370.29
83,100.00	97,515.00	77,647.50	92,820.00	100,012.50
22,304.86	31,700.70	22,324.84	26,978.40	28,642.21

Means followed by equal letters in the rows indicate no difference by Tukey's test ($p > 0.05$).
[1] Acquisition of lambs = R$ 3.50/kg LW (SI) and R$ 4.00 kg LW (½D-SI).
[2] Labor = (R$ 3.24 per day/8 h × days in feedlot).
[3] Total income = R$ 10.00/kg carcass (Santa Inês) and R$ 11.00/kg carcass (½D-SI).

Table 4. Means and standard deviations for quantitative carcass characteristics of lambs according to breed group and subcutaneous fat thickness at slaughter

	Breed groups		Fat thickness		
Item [1]	SI	½D-SI	2.0 mm	3.0 mm	4.0 mm
CCY (%)	49.39 ± 0.12	50.68 ± 0.11	47.22 ± 0.15c	48.98 ± 0.14b	49.91 ± 0.15a
TCY (%)	56.63 ± 0.11	57.58 ± 0.10	54.74 ± 0.13c	55.91 ± 0.12b	56.60 ± 0.12a
CL (kg)	0.09 ± 0.24	0.08 ± 0.22	0.07 ± 0.29	0.07 ± 0.27	0.06 ± 0.28
CCI (kg/cm)	0.26± 0.08	0.28 ± 0.08	0.24 ± 0.10b	0.28 ± 0.09a	0.29 ± 0.10a
LCI	0.52 ± 0.10	0.53 ± 0.09	0.53 ± 0.12	0.53 ± 0.12	0.54 ± 0.12

Means followed by equal letters in the rows indicate no difference by Tukey's test ($p > 0.05$).
[1] CCY = commercial carcass yield; TCY = true carcass yield; CL = cooling loss; CCI = carcass compactness index; LCI = leg compactness index. SI = Santa Inês; ½D+SI = Dorper + Santa Inês.

Variables CL and LCI were not affected by breed group or subcutaneous fat thickness of the lambs at slaughter. Greater CCI were observed for the animals slaughtered with subcutaneous fat thicknesses of 3.0 and

4.0 mm as compared with those of 2.0 mm. The average CCI in the present experiment was 0.27 kg/cm, which is higher than the 0.22 kg/cm obtained by Santello *et al.* (2010). Such superiority in CCI values can be explained by the higher slaughter weights of the present study, reflecting in the direct relationship between slaughter weight and carcass compactness index, which demonstrates that CCI is directly proportional to the slaughter weight.

Breed groups did not affect ($p > 0.05$) the components of the body weight of the lambs. This result corroborates Ítavo *et al.* (2009), Marple (1983) and Berg & Butterfield (1976), who reported that organs and viscera have early development, which occurs at a greater intensity in the first life stages of the animal.

Table 5. Means and standard deviations for the body weight components of lambs according to breed group and fat thickness at slaughter

	Breed group		Fat thickness		
Item	SI	½D-SI	2.0 mm	3.0mm	4.0 mm
Bodyweight at slaughter (kg)	33.63 ± 3.24	35.07 ± 2.79	31.36 ± 2.94c	33.48 ± 3.29b	38.22 ± 2.83a
Hot carcass weight (kg)	17.55 ± 1.60	18.57 ± 0.83	15.56 ± 1.40c	18.43 ± 1.28b	20.19 ± 0.96a
Blood (%)	4.20 ± 0.14	4.29 ± 0.20	4.31 ± 0.20	4.35 ± 0.13	4.07 ± 0.17
Skin (%)	8.63 ± 0.21	9.20 ± 0.30	8.42 ± 0.20	9.22 ± 0.21	9.10 ± 0.36
Reproductive system (%)	1.51 ± 0.08	1.62 ± 0.04	1.48 ± 0.07	1.66 ± 0.09	1.56 ± 0.03
Kidneys and perirenal fat (%)	1.28 ± 0.08	1.33 ± 0.08	1.19 ± 0.07	1.27 ± 0.07	1.45 ± 0.08
Spleen (%)	0.26 ± 0.01	0.24 ± 0.01	0.24 ± 0.01	0.22 ± 0.01	0.29 ± 0.01
Liver (%)	2.09 ± 0.08	2.04 ± 0.08	2.07 ± 0.08	2.12 ± 0.08	2.02 ± 0.08
Empty gastrointestinal tract (%)	10.69 ± 0.43	10.18 ± 0.43	10.17 ± 0.32	10.81 ± 0.50	10.33 ± 0.48
Gastrointestinal content (%)	8.18 ± 0.56	7.83 ± 0.63	9.42 ± 0.64	7.97 ± 0.48	6.63 ± 0.67
Heart (%)	0.55 ± 0.03	0.56 ± 0.04	0.52 ± 0.03	0.53 ± 0.04	0.61 ± 0.03
Respiratory tract (%)	2.49 ± 0.09	2.41 ± 0.08	2.59 ± 0.10	2.59 ± 0.10	2.16 ± 0.07
Head (%)	5.52 ± 0.12	5.64 ± 0.12	5.65 ± 0.14	5.72 ± 0.11	5.38 ± 0.11
Limb extremities (%)	2.59 ± 0.09	2.63 ± 0.09	2.60 ± 0.09	2.58 ± 0.09	2.59 ± 0.09

Means followed by equal letters in the rows indicate no difference by Tukey's test ($p > 0.05$).
SI = Santa Inês; ½D-SI = ½Dorper + ½Santa Inês.

Table 6 displays the means and standard deviations for the yields of seven commercial cuts in relation to the half-carcass. In the data pertaining to breed group, we can observe that the loin yield of crossbred animals was higher than that of pure Santa Inês lambs, possibly due to the genetic composition, in which this breed presents 50% of a meat-specialized genotype. However, the other cuts were similar between the different breed groups. According to Osório *et al.* (2002), when carcasses show similar weights and fat contents, almost all the regions of the body have similar proportions, irrespective of breed.

Table 6. Means and standard deviations for the commercial cuts of lambs from two breed groups slaughtered with three fat thicknesses

	Breed group			Fat thickness	
Item	SI	½D-SI	2.0 mm	3.0 mm	4.0 mm
Leg (%)	30.22 ± 0.03	30.09 ± 0.02	30.26 ± 0.02	30.41 ± 0.03	29.10 ± 0.02
Loin (%)	11.16 ± 0.02b	12.29 ± 0.01a	11.10 ± 0.02	11.60 ± 0.01	11.49 ± 0.01
Shoulder (%)	19.06 ± 0.03	18.38 ± 0.01	20.12 ± 0.01a	18.87 ± 0.03a	17.97 ± 0.02b
Ribs (%)	7.06 ± 0.01	7.24 ± 0.01	6.84 ± 0.01b	7.38 ± 0.01a	7.23 ± 0.01a
False ribs (%)	8.97 ± 0.01	9.80 ± 0.02	9.02 ± 0.01	9.44 ± 0.02	9.70 ± 0.01
Breast+Flank (%)	14.07 ± 0.02	14.89 ± 0.02	13.78 ± 0.01b	13.37 ± 0.01b	16.88 ± 0.02a
Neck (%)	7.56 ± 0.01	7.36 ± 0.01	7.67 ± 0.01	7.52 ± 0.01	7.19 ± 0.01

Means followed by equal letters in the rows indicate no difference by Tukey's test ($p > 0.05$).
SI = Santa Inês; ½D-SI = ½Dorper-Santa Inês.

The higher values for percentage of shoulder found in the lambs slaughtered with 2.0 and 3.0 mm compared with those slaughtered with 4.0 mm can be explained by the early development of this anatomical region, because these lambs were slaughtered with a lower number of days in feedlot and with lower slaughter weights. Rosa *et al.* (2002) and Osório *et al.* (2002) also verified early muscle growth in the shoulder as compared with the other carcass components.

The measures LEA, C, FTUS and J, presented in Table 7, showed no differences for breed group. However, in all these variables, greater value was found for the animals slaughtered with 4.0 mm of thickness, followed by 3.0 and then 2.0 mm. The loin-eye area, measured at the *longissimus* muscle, has shown to be directly related to the total muscle in the carcass, whereas the subcutaneous fat thickness is directly linked to the total fat in the carcass and indirectly linked to the amount of muscles, since fat accumulation decreases as the proportion of muscles is increased (Forrest *et al.*, 1979).

Table 7. Means and standard deviations for loin-eye area (LEA), fat thickness (Measurement C), fat thickness measured by ultrasound pre-slaughter (FTUS), greatest fat thickness (Measurement J), and tissue composition of the loin of Santa Inês (SI) and ½Dorper + ½Santa Inês (DSI) lambs slaughtered with different subcutaneous fat thicknesses

	Genotype		Fat thickness		
Item	SI	D-SI	2.0 mm	3.0 mm	4.0 mm
LEA (cm^2)	12.77 ± 0.18	13.59 ± 0.16	12.20 ± 0.21a	13.18± 0.21b	14.17 ± 0.22c
Measurement C	3.08 ± 0.17	3.14 ± 0.20	2.28 ± 0.19a	3.18 ± 0.22b	3.88 ± 0.15c
FTUS (mm)	3.13 ± 0.15	3.17 ± 0.18	2.25 ± 0.23a	3.11 ± 0.17b	4.09 ± 0.11c
Measurement J	3.56 ± 0.25	3.69 ± 0.36	2.78 ± 0.35a	3.71 ± 0.31b	4.39 ± 0.25c
Muscle (%)	51.06	52.40	49.44a	50.73a	55.02b
Fat (%)	27.47	27.72	26.63	27.92	28.24
Bone (%)	21.45	19.86	23.91a	21.02a	17.04b

Means followed by equal letters in the rows indicate no difference by Tukey's test ($p > 0.05$).

These values corroborate Cartaxo *et al.* (2009), who worked with Santa Inês and ½Dorper + ½Santa Inês lambs slaughtered with different body condition scores, and verified higher LEA for the lambs slaughtered at average and fat conditions, compared with thin lambs.

Adequate subcutaneous fat layer is indispensable for production of better carcasses. Regarding measurement FTUS, we found values very close to those found in the animal carcass with the caliper rule, thus confirming the reliability of measurements made by ultrasound.

The knowledge of the tissue composition is of utmost importance, because the carcass, with its varied commercial cuts, has edible and non-edible parts like bones, which correspond to the most part, and the fat tissue, although edible, has low commercial value, and when in excess may be restrictive for the choice of the consumer.

The proportions of muscle, fat and bone in the loin of the lambs did not differ ($p > 0.05$) among the genotypes, which corroborates the data found by Amaral (2010). This is likely related to the non-combination of the desirable characteristics of the specific breed for meat production with the Santa Inês breed, and which in this case did not reflect in heterosis.

Differences were observed ($p < 0.05$) for the proportions of muscle and bone among the fat thickness assessed. Lambs slaughtered with 4.0 mm of fat thickness showed greater muscle proportion and smaller bone proportion as compared with the other thicknesses. Strydom *et al.* (2009), analyzing the composition of the main carcass cuts, with five different fat scores, verified that the proportions of bone reduced significantly as the fat was increased.

CONCLUSION

Lambs slaughtered with 2.0 and 3.0 of fat thickness present better feed conversion. However, those slaughtered with 4.0 mm of fat thickness have better economic results.

Lambs slaughtered with greater fat thickness have improved quantitative and qualitative carcass characteristics.

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