SCAP
SOCIEDADE DE CIÊNCIAS AGRÁRIAS DE PORTUGAL

Carcass characteristics of Santa Inês lambs finished on native pasture and subjected to different types of supplementation

Características de carcaça de cordeiros Santa Inês terminados em pastagem natural e submetidos a diferentes tipos de suplementação

José M. Pereira Filho[1], Aderbal M. A. Silva[1], Divan S. Silva[1] Marcílio F. Cézar[1], Leilson R. Bezerra[2], Sara R. M. Rufino[1] Jucileide B. Borburema[1] e Geraldo F. V. Bayão[2,3]

[1] *Department of Animal Science, Institute Agricultural Sciences, Federal University of Campina Grande, Patos, Paraíba State, 58109-900, Brazil. Email: jmorais@cstr.ufcg.edu.br; silvaama@gmail.com; divan13silva@gmail.com; mfcezar@gmail.com; sarareginar@yahoo.com.br; jucileidebarboza@hotmail.com*

[2] *Department of Animal Science, Institute Agricultural Sciences, Federal University of Piauí, Bom Jesus, Piauí State, 64900-000, Brazil. Email: leilson@ufpi.edu.br.*

[3] *Campus Professora Cinobelina Elvas, University Federal of Piauí, BR 135, km 03, Bairro Planalto Horizonte, Bom Jesus, Piauí State, Brazil. Email: gfbayao@gmail.com, author for correspondence*

Received/Recebido: 2014.03.21
Accepted/Aceite: 2014.09.18

ABSTRACT

This study aimed to evaluate the biometric measurements and characteristics of the carcass and retail cuts of 24 Santa Inês whole lambs finished in native pasture with different supplements. The animals were divided into four experimental diets: 200 g/day of a protein-energy supplement plus sodium chloride; 200 g/day of the protein-energy-mineral supplement; 300 g/day of the protein-energy-mineral supplement and 300 g/day of the protein-energy-min supplement without manganese. A complete randomized experimental design with four treatments and six replications was used. The supplements did not influence the biometric measurements, body score, slaughter weight, loss by cooling, weight of the half carcass, hot carcass yield, cold carcass yield or the biological yield and weight of retail cuts from the Santa Inês lambs. The weights of hot and cold carcass, empty body, gastrointestinal-tract contents and leg of the lambs that received 300 g/day of supplement without manganese were higher than those of lambs that received 200 g/day of supplement. The energetic protein-mineral supplementation systems evaluated were effective in obtaining quality carcasses under finishing recommendations of Santa Inês sheep on native pasture with an initial weight of approximately 19.9 kg and slaughtered at 200 days old.

Keywords: biological yield, caatinga, retail cuts, semiarid, sheep

RESUMO

O objetivo do trabalho consistiu em avaliar as medidas biométricas e as características de carcaça e cortes comerciais de 24 cordeiros Santa Inês inteiros, terminados em pastagem natural com diferentes suplementos. Os animais foram distribuídos por quatro dietas experimentais: 200g/dia do suplemento proteico-energético mais cloreto de sódio; 200 g/dia do suplemento proteico-energético-mineral; 300g/dia do suplemento proteico-energético-mineral e 300 g/dia do suplemento proteico-energético-mineral sem manganês. Utilizou-se um delineamento experimental inteiramente casualizado com quatro tratamentos e seis repetições. Os suplementos não influenciaram as medidas biométricas, a condição corporal, o peso ao abate, a perda por resfriamento, o peso da meia carcaça, os rendimentos de carcaça quente, carcaça fria e biológica e o peso dos cortes comerciais dos cordeiros Santa Inês. O peso de carcaça quente e fria, da carcaça vazia, do conteúdo gastrintestinal e da perna dos cordeiros suplementados com 300 g/dia sem manganês foram superiores aos obtidos pelos cordeiros que receberam 200 g/dia de suplemento. Os sistemas de suplementação proteico-energético-mineral avaliados foram eficientes na obtenção de carcaças, sendo recomendada o acabamento de ovinos Santa Inês em pastagem natural com peso inicial em torno de 19,9 kg e o abate aos 200 dias de idade.

Palavras-chave: caatinga, cortes comerciais, ovinos, rendimento biológico, semiárido

Introduction

The sheep industry is considered a promising economic activity for the Brazilian semiarid region, and the Caatinga vegetation can serve as the main food supply for sheep. However, the soil and climatic characteristics of the region contribute to the seasonality of forage production, making the establishment of feeding strategies in herds necessary. The herds often require supplemental forage production and the rational use of a protein, energy and mineral concentrate.

The finishing of sheep fed exclusively on native pasture in the Brazil semiarid region requires more takes longer for the animals to reach the slaughter weight required by the market. However, although it is faster and provides carcasses with better yields, finishing sheep in feedlots with diets based on concentrate may be inaccessible to the majority of farmers, especially due to costs of feeding and facilities (Dantas *et al.*, 2008).

It is important to recognize how climatic conditions, mainly rainfall, might reduce the availability and quality of forage. The concentrate supplementation of sheep is needed for better use the forage potential of the region and to produce higher-quality carcasses. Thus supplements that have been developed for when supplied to pastured animals double the weight gain and result in carcass weight between 2-15 kg, and carcass yield higher than 40%, in the case of animals from Santa Inês (Cardoso *et al*., 2013). These animals are promising for meat production on pasture (Santos *et al.*, 2010; Menezes *et al.*, 2013) and in confinement (Moyo *et al.*, 2012; Souza Jr. *et al.*, 2013).

The minerals needs usually are not clearly defined in ruminants diets in addition several factors cause interference with its absorption, among them: the presence and absorption of Zn and Mn which can be affected by other nutrients such as Ca, Fe, P, Cd and Cr (Zn) and even promote antagonism between them (Mendes *et al.*, 2010). Thus, knowledge of supplementation with different levels of these minerals and their relationship with the mineralization are fundamental to the performance of sheep and directly reflect the final quality of the carcass to be sold. Moreover, manganese is an essential element for the normal structure of bones and directly affects the growth and weight gain of the animals in its deficiency is associated with reduced growth of decreased tissue deposition (Cotta, 2001).

Carvalho Jr *et al.* (2009) noted that concentrate and/or mineral supplementation of animals finished on pasture needs to be improved to obtain the most appropriate level of supplementation in order to maximize the productive and economic performance, based on a carcass compatible quality with consumer demands. The aim of this study was to evaluate the biometric measurements and the characteristics of the carcass and retail cuts of Santa Inês lambs finished on native pasture and submitted supplementation protein-energy-mineral.

Materials and Methods

Location of the study

The experiment was performed at the Nupeárido farm of the Federal University of Campina Grande (FUCG) in the city of Patos, Paraíba, corresponding to the geographic coordinates 7° 1' latitude south and 37° 18' longitude west. The weather is classified hot and dry with average temperatures of approximately 30°C, and characterized by two distinct seasons: a rainy season from January to May, and a dry season from June to December, with an average rainfall of 500 mm/year.

Diets and animals

The research was conducted according the legal aspects of animal research and was approved by the Ethics Committee on animal research at the Federal University of Campina Grande, Paraiba, Brazil.

The experimental area consisted of 8,670 m^2 and was divided into three paddocks composed of native pasture and containing a flora composition of 89.2% herbaceous extract and 10.8% (939.7 m^2) land covered by woody plants. Among the herbaceous vegetation were grasses such as Alexander grass (*Brachiaria plantaginea* (Link) Hitchc. and *Panicum* sp.), foxtail grass (*Setaria* sp.) and cocksfoot grass (*Aristida setifolia* Kunth) and among the dicotyledonous species were the legumes Townsville stylo (*Stylosanthes humilis* Kunth) centrosema (*Centrosema* sp.) and sicklepod (*Senna obtusifolia* L.).

Twenty-four Santa Inês lambs, uncastrated males, with an average initial body weight of 19.9±3.12 kg and an average initial age of 140 days were used. The lambs were identified and treated with dewormer and vitamin complex ADE. The animals were kept on native pasture for 75 days, considering the first 15 days as an adaptation period for the animals. The average daily weight gain expected was 150-180 g/day. To track the weight gain of the animals, the lambs were weighed every 15 days, always at 7 am after fasting for 16 hours. The grazing time of the animals in each paddock was limited by the grazing pressure. When the availability of herbaceous forage was reduced to 60% of that on the date of entry

of the initial amount in the beginning of the trial, the animals were transferred to another paddock, allowing the area to rest for a period ranging from 12 to 20 days, according to the level of herbaceous grazing.

The handling consisted of grazing from 7 am to 4 pm, when the sheep were gathered in the handling corral to receive supplementation and water *ad libitum*. Four supplementation strategies were used as treatments: supplementation with 200 g/day of protein-energy supplement (S) and sodium chloride (NaCl); supplementation with 200 g/day of protein--energy-mineral supplement (SMM2); supplementation with 300 g/day of protein-energy-mineral supplement (SMM3) and supplementation with 300 g/day of protein-energy-mineral supplement without manganese (SMM - Mn). The use of 200 and 300 grams of concentrated aimed to check possible limitations of energy and protein in the bush diet consumed by grazing animal in the bush, since some depends on the floristic composition, quantity and quality of dry matter available to and animals, limitations may occur on one or more nutrients such as protein, energy, and minerals (Pereira Filho *et al.*, 2013).

The chemical composition of the components of diets and herbaceous vegetation of the experimental area and composition of ingredients (%) in the different protein-energy-mineral supplements are described in Tables 1 and 2, respectively.

Table 1 – Chemical composition of the components of the diets and herbaceous vegetation of the experimental area

Component	DM (%)	CP[1]	NDF[1]	MM[1]	CE*	Mn**	Zn**
Soybean meal	91.64	45.96	14.57	6.00	4.9	46.00	110
Ground corn	90.00	12.63	41.93	2.41	4.3	38.00	34
Grasses	43.26	6.84	66.53	7.68	4.5	89	185
Dicotyledonous	47.35	14.42	51.36	6.96	4.1	100	108

[1] Data expressed based on dry matter; * in Mcal/kg; ** in ppm; DM - dry matter; CP - crude protein; NDF - neutral detergent fiber; MM - mineral matter; CE - crude energy; Mn - manganese; Zn - zinc.

Table 2 – Composition of ingredients (%) in the different protein-energy-mineral1 supplements.

Ingredient	S+NaCl	SMM[2]	SMM[3]	SMM-Mn
Ground corn	37.37	33.30	33.85	33.85
Soybean meal	37.37	33.30	33.85	33.85
Mineral mix[1]	0.00	15.27	16.68	16.68
Urea (%)	6.58	3.36	3.67	3.67
Common salt	18.68	14.77	11.95	11.95
Total	100	100	100	100
CP (g/kg)	3.009	2.705	2.817	2.817
ME (Mcal/kg)	2.43	2.17	2.22	2.22
Ca (%)	0.16	3.45	3.25	3.25
P (%)	0.33	2.12	2.02	2.02
Mn (ppm)	0	600	600	0
Zn (ppm)	0	600	600	600

CP - crude protein; ME - metabolizable energy; Ca – calcium; P – phosphorus; Mn - manganese and Zn - zinc.
[1] Mineral mix: 123.8 g of Ca/kg, 68 g of P/kg, 12 g of S/kg, 600 ppm of Cu, 100 ppm of Co, 368 ppm of Fe, 120 ppm of I and 12 ppm of Se.

Results and Discussion

There was no significant difference (p>0.05) among the treatments for the biometric measurements and body score (Table 3). The animals that received the protein-energy-mineral supplementation without manganese (SMM-Mn) presented values of 64.1, 73.0 and 1.8 cm for body length, heart girth and body score, respectively. These values of biometric measurements and body score are considered good for animals grazed on pasture with supplementation highlighting the high correlation of these variables with body weight in young Santa Inês sheep (43 kg), particularly the body score, which according to Pinheiro and Jorge (2010) is an important factor to determine with accuracy the other measurements in vivo and of in animals' carcass.

Table 3 – Averages of the biometric measurements of lambs finished in native pasture and subjected to different types of supplementation.

Ingredient	S+NaCl	SMM[2]	SMM[3]	SMM-Mn
Ground corn	37.37	33.30	33.85	33.85
Soybean meal	37.37	33.30	33.85	33.85
Mineral mix[1]	0.00	15.27	16.68	16.68
Urea (%)	6.58	3.36	3.67	3.67
Common salt	18.68	14.77	11.95	11.95
Total	100	100	100	100
CP (g/kg)	3.009	2.705	2.817	2.817
ME (Mcal/kg)	2.43	2.17	2.22	2.22
Ca (%)	0.16	3.45	3.25	3.25
P (%)	0.33	2.12	2.02	2.02
Mn (ppm)	0	600	600	0
Zn (ppm)	0	600	600	600

BL - body length; HB - height of the back; RH - rump height; CW - chest width; RW - rump width; HG - heart girth; LL - leg length; TC - thigh circumference; SC - scrotal circumference; BS -body score.

In general, the causes responsible for variations in the biometrics measurements are related to animals' genetics and carcass subcutaneous fat covering of the animal (Lôbo *et al.*, 2013; Oliveira *et al.*, 2013). Costa Jr *et al.* (2006) evaluated the body measurements of Santa Inês sheep and found a body length of 56.9 cm, a back height of 58.7 cm, a rump height of 60.7 cm and a heart girth of 68.3 cm, values lower than those found in similar animals studied. The value of meat to the purchaser is mostly dependent on eating quality, keeping quality and nutritional value. All these can be influenced by nutrition and the genetic of animals. Minerals including trace elements and vitamins are vital components that contribute to the nutrient value of meat in terms of physiological and biochemical functions (Ponnampalam *et al.*, 2014). The weights of the hot carcass, cold carcass, empty body and gastrointestinal tract were influenced (p<0.05) by the protein-energy-mineral supplementation (Table 4), while the slaughter weight, hot carcass yield, cold carcass yield, biological yield and the loss by cooling losses did not differ among the types of supplementation tested (p>0.05).

The animals that received 300 g of supplement with or without manganese showed similar hot carcass and cold carcass weights, indicating that the native pasture composition of 10% CP and 58% NDF and with availability of DM ranging from 1116 to 2265 kg/ha most likely have sufficient Mn for the proper development of the sheep, with no need for supplementation with this mineral. In contrast, the carcass weights obtained in the treatments with 200 g of the protein-energy-mineral supplements were lower than those observed in sheep that received protein--energy-mineral supplements without Mn but were similar (p>0.05) to the weights those receiving Mn.

The yields of the hot carcass and the cold carcass, the biological yield and the loss by cooling were not affected by the protein-energy-mineral supplements (Table 4). The protein-energy-mineral supplements influenced (p<0.05) the weight of sheep's leg weight, and there was no difference (p>0.05) in the characteristics of the half carcass, loin, rib, shoulder and neck or in the yields of the leg, loin, rib, shoulder

Table 4 – Average weight (kg) and yield of Santa Inês lambs finished on native pasture and subjected to different types of supplementation.

Variable	S+NaCl	SMM[2]	SMM[3]	SMM-Mn	CV (%)
SW (kg)	26.73	26.26	28.44	29.35	4.51
HCW (kg)	12.30[a]	12.32[a]	12.96[ab]	13.61[b]	5.00
CCW (kg)	12.00[a]	11.98[a]	12.59[ab]	13.31[b]	5.65
EBW (kg)	22.82[a]	22.90[a]	24.13[b]	24.98[b]	2.12
GIC (kg)	3.91[ab]	3.36[a]	4.30[b]	4.36[b]	12.98
HCY (%)	45.98	46.94	45.53	46.37	4.88
CCY (%)	44.88	45.64	44.23	45.36	5.46
BY (%)	53.31	54.37	53.64	54.48	3.40
LC (%)	2.42	2.76	2.91	2.18	12.25

Averages followed by different letters in the row differ based on Tukey's test (P<0.05). SW - slaughter weight; HCW - hot carcass weight; CCW - cold carcass weight; EBW - empty body weight; GIC - gastrointestinal content; HCY - hot carcass yield; CCY - cold carcass yield; BY - biological yield; LC - loss by cooling.

and neck (Table 5). Importantly, even increasing from 200 to 300 g of supplement/day, the yields did not change. This fact can be attributed to the forage availability and to the ability of Santa Inês sheep to select botanical species of superior nutritive value in areas with high floristic diversity, which can result in diets with a chemical composition that exceeds the maintenance needs, facilitating a more efficient use of the protein and energy, similar results to those reported by Cabral *et al.* (2013) and Costa *et al.* (2013) in research with sheep Santa Inês and Morada Nova, respectively.

Weight loss by cooling (WLC) with an average of 2.5% is considered normal. According to Martins *et al.* (2000) that evaluated lambs Ideal race with 123 days of age, weighing between 16 and 37 kg, the indices of loss by cooling losses are approximately 2.5% in sheep, and this value may differ between 1 and 7% according to the uniformity of the fat coverage, sex and weight of the carcass and the temperature and relative humidity of the cold chamber.

The legs weight of sheep supplemented with and without Mn were similar. However, the animals that received 300 g of supplement without Mn showed legs 10.8% heavier comparing to animals fed 200 g of supplement.

Peixoto *et al.* (2005) and Teixeira *et al.* (2013) stated that mineral supplementation of animals that are not properly nourished in energy and protein should be avoided because since animals do not benefit from the minerals ingested because the body prioritizes the nutritional components required in larger quantities, such as energy and protein, over minerals and vitamins. This pattern may explain the results obtained in the biometric measurements (Table 3), for the characteristics SW, HCY, CCY, BY and LC (Table 4) and for weight and yield of retail cuts (Table 5) in the NaCl treatment relative to the

Table 5 – Average values of the weight (kg) and yield (%) of the retail cuts of lambs finished in native pasture and subjected to different types of supplementation.

Component	S+NaCl	SMM[2]	SMM[3]	SMM-Mn
Half carcass (kg)	5.87	5.86	6.12	6.41
Leg (kg)	1.99[a]	2.01[a]	2.11[ab]	2.24[b]
Loin (kg)	0.60	0.58	0.63	0.65
Ribs (kg)	1.52	1.50	1.56	1.59
Shoulder (kg)	1.17	1.17	1.23	1.28
Neck (kg)	0.59	0.58	0.60	0.64
Leg (%)	33.99	34.47	34.45	34.98
Loin (%)	10.16	9.83	10.29	10.19
Ribs (%)	25.85	25.73	25.43	24.82
Shoulder (%)	20.00	20.08	20.06	20.03
Neck (%)	10.01	9.88	9.77	9.99

Averages followed by different letters in the row differ based on Tukey's test (P<0.05).

addition of other minerals. The differences might indicate a need to adjust the supplementation based on energy and protein levels of the feed.

The cuts of leg, loin, ribs, shoulder and neck showed average yields of 34.4%, 10.1%, 25.4%, 20% and 9.9%, respectively (Table 5). The results demonstrated the highest representativeness of the leg and shoulder compared to the other cuts. Aspect that can be attributed to the fact that animals are a breed quite adapted to semiarid region and being raised in a pasture system. Importantly, the leg is considered the cut with the highest commercial value, followed by the loin and shoulder, and thus, the leg is the cut that provides enhanced economic value to the carcass (Pilar *et al.*, 2006).

Conclusion

Supplementation with 300 g/day of the protein--energy-mineral supplement with and without manganese resulted in greater carcass weight and the yield of the animals' leg, which is considered one of the most important retail cuts.

The isolated presence of manganese in mineral supplementation did not influence the weight of commercial cuts that were most associated with its reduction amount of mineral supplement provided.

The energetic protein-mineral supplementation systems evaluated were effective in obtaining quality carcasses under the recommendations of for Santa Inês sheep finishing on native pasture with an initial weight of approximately 19.9 kg and slaughtered at 200 days old.

References

AOAC (Association of Official Analytical Chemists) (1984). *Official Methods of Analysis*. 14th. Editora Virginia, 1141p.

Cabral, I.S.; Azevêdo, J.A.G; Almeida, F.M; Pereira, L.G.R; Araújo, G.G.L.A; Cruz, C.L.S; Nogueira, A.S; Souza, L.L and Oliveira, G.A. (2013) - Performance and characteristics of carcass and non--carcass components of lambs fed peach-palm by-product. *Tropical Animal Health and Production*, vol. 45, n. 8, p. 1737-1743.

Cardoso, M.T.M; Landim, A.V; Louvandini, H. and McManus C. (2013) - Performance and carcass quality in three genetic groups of sheep in Brazil. *Brazilian Journal of Animal Science*, vol. 42, n. 10, p. 734-742.

Carvalho Jr, A.M; Pereira Filho, J.M; Silva, R.M; Cezar, M.F; Silva, A.M.A and Silva A.L.N. (2009) - Effect of supplemental feeding on carcass and non-carcass characteristics of F1 (Boer × SRD) goats finished on native pasture. *Brazilian Journal of Animal Science*, vol. 38, n. 7, p. 1301-1308.

Colomer-Rocher, F.; Morand-Fehr, P. and Kirton, A.H. (1987) - Standard methods and procedures for goat carcass evaluation, jointing and tissue separation. *Livestock Production Science*, vol. 17, p.149-159.

Costa, M.R.G.F.; Pereira, E.S.; Silva, A.M.A; Paulino, P.V.R; Mizubuti, I.Y.; Pimentel, P.G.; Pinto, A.P. and Rocha Junior, J.N. (2013) - Body composition and net energy and protein requirements of Morada Nova lambs. *Small Ruminant Research*, vol. 114, n. p. 206–213.

Costa Jr, G.S.; Campelo, J.E.G.; Azevedo, D.M.M.R.; Martins Filho, R.; Cavalcante, R.R.; Lopes, J.B. and Oliveira, M.E. (2006) - Morphometric characterization of Santa Inês sheep raised in the regions of Teresina and Campo Maior, Piauí. *Revista Brasileira de Zootecnia*, vol. 35, n. 6, p. 2260-2267.

Cotta, T. (2001) -Minerais e vitaminas para bovinos, ovinos e caprinos. Viçosa: Aprenda Fácil

Dantas, A.F.; Pereira Filho, J.M.; Silva, A.M.A.; Santos, E.M.; Sousa, B.B. and Cezar, M.F. (2008) - Carcass characteristics of Santa Inês sheep finished in grazing and submitted to different levels of supplementation. *Ciência e Agrotecnologia*, vol. 32, n. 4, p. 1280-1286.

Lôbo, A.M.B.O.; Bomfim, M.A.D.; Facó, O.; Júnior, G.A.F.;, Ponciano, M.F. and Lôbo, R.N.B. (2013) - Intramuscular fat and fatty acid profile of muscle of lambs finished in irrigated pasture. *Journal of Applied Animal Research*, vol. 41, p.1-8.

Martins, R.R.C.; Oliveira, N.M.; Osorio, J.C.S. and Osório, M.T.M. (2000) - *Peso vivo ao abate como indicador do peso e das características quantitativas e qualitativas das carcaças em ovinos jovens da raça Ideal*. 1a ed. Bagé, Embrapa Pecuária Sul, 27 p.

Mendes, R.S.; Silva, A.M.A.; Silva, G.L.S.; Nóbrega, G.H.; Lôbo, K.M. and Pereira Filho, J.M. (2010) - Exigência líquida de zinco, cobre e ferro para cordeiros em pastejo no semiárido. Acta Scientiarum. *Animal Sciences*, vol. 32, n. 3, p. 279-284.

Menezes, A.M.; Louvandini, H.; Esteves, G.I.F.; Dalcin, L.; Canozzi, M.E.A.; Barcellos, J.O.J. and McManus, M. (2013). Performance and carcass traits of Santa Inês lambs finished with different sources of forage. *Brazilian Journal of Animal Science*, vol. 42, n. 6, p. 428-437.

Moyo, B.; Masika, P.J. and Muchenje, V. (2012) - Effect of supplementing crossbred Xhosa lop-ea-

red goat castrates with Moringa oleifera leaves on growth performance, carcass and non-carcass characteristics. *Tropical Animal Health and Production*, vol. 44, n. 4, p. 801-809.

Oliveira, P.B.; Lima, P.M.T.; Campeche, A.; Mendonça, S.; Laviola, B.G.; McManus, C. and Louvandini, H. (2013) - Growth and carcass characteristics of Santa Inês lambs fed diet supplemented with physic nut meal free of phorbol ester. *Small Ruminant Research*, vol. 114, n. 1, p. 20–25.

Osório, J.C.S.; Osório, M.T.M.; Jardim, P.O.; Pimentel, M.; Pouey, J.L.; Luder, W.E.; Cardellino, R.A.; Oliveira, N.M.; Borba, M.F.; Motta, F. and Esteves, R. (1998) - *Métodos para avaliação da produção da carne ovina: in vivo, na carcaça e na carne*. 1a ed. Pelotas, Editora Universitária. 107 p.

Pereira Filho, J.M.; Silva, A.M.A. and Cezar, M.F. (2013) - Management of the Caatinga for the production of goats and sheep. *Revista Brasileira Saúde de Produção Animal*, vol. 14, n. 1, p. 77-90.

Peixoto, P.V.; Malafaia, P.; Barbosa, J.D. and Tokarnia, C.H. (2005) - Princípios de suplementação mineral em ruminantes. *Pesquisa Veterinária Brasileira*, vol. 25, n. 3, p. 195-200.

Pilar RC, Pérez JRO and Nunes FM. (2006) - Relative composition of carcass cuts in Australian merino and crossbreed of Ile de France x Australian merino lambs slaughtered at different weights. *Agrociência*, vol. 2, n. 4, p. 461-469.

Pinheiro, R.S.B. and Jorge, A.M. (2010) - Biometric measurements obtained in vivo and in the carcass of culled ewes at different physiological stages. *Brazilian Journal of Animal Science*, v. 39, n. 2, p. 440-445.

Ponnampalam, E.N.; Butlerc, K.L.; Jacobd, R.H.; Pethicke, D.W.; Ballf, A.J.; Edwardsg, J.E.H.; Geesinkh, G. and Hopkinsi, D.L. (2014) - Health beneficial long chain omega-3 fatty acid levels in Australian lamb managed under extensive finishing systems. *Meat Science*, vol. 96, n. 2, p.1104–1110.

Santos, J.R.S.; Pereira Filho, J.M.; Silva, A.M.A.; Cezar, M.F.; Borburema, J.B. and Silva J.O.R. (2010) - Feeding supplementation effect on physical and chemical composition of shoulder, ribs, and neck of Santa Inês lambs finished on pasture. *Arquivo Brasileiro de Medicina Veterinária e Zootecnia*, v. 62, n. 4, p. 906-913.

Silva, D.J. and Queiroz, A.C. (2002) - *Análise de alimentos (métodos químicos e biológicos)*. 2a ed. Viçosa, Imprensa Universitária, 235p.

Souza Jr, E.L.; Sousa, W.H.; Pimenta Filho, E.; Gonzaga Neto, S.; Cartaxo, F.Q.; Cezar, M.F.; Cunha, M.G.G. and Pereira Filho, J.M. (2013) - Effect of frame size on performance and carcass traits of Santa Inês lambs finished in a feedlot. *Brazilian Journal of Animal Science*, vol. 42, n. 4, p. 284-290.

Statistical Analysis Sistem - SAS. Stat 9.1. (2004) - Cary: SAS Institute Publishing., software version 3. *User's Guide*.

Teixeira, I.A.M.A.; Resende, K.T.; Silva, A.M.A.; Silva Sobrinho, A.G. and Härter, C.J. and Sader, A.P.O. (2013) - Mineral requirements for growth of wool and hair lambs. *Brazilian Journal of Animal Science*, vol. 42, n. 5, p. 347-353.

Yáñez, E.A.; Resende, K.T.; Ferreira, A.C.D.; Medeiros, A.N.; Silva Sobrinho, A.G.; Pereira Filho, J.M.; Teixeira, I.A.M.A. and Artoni, S.M.B. (2004) - Utilization of Biometric Measures for Prediction of Saanen Goats Carcass Traits. *Brazilian Journal of Animal Science*, vol. 33, n. 6, p. 1564-1572.