Revista Brasileira de Zootecnia

ISSN 1806-9290
www.sbz.org.br

R. Bras. Zootec., v.39, n.6, p.1322-1327, 2010

Carcass characteristics and cuts of Santa Inês lambs fed different roughage proportions and fat source[1]

Iraides Ferreira Furusho Garcia[2], Amélia Katiane de Almeida[2], Tharcilla Isabella Rodrigues Costa[2], Izac Leopoldino Júnior[2], Julimar do Sacramento Ribeiro[2], Fernando Antonio de Souza[2]

[1] *Financiado pela FAPEMIG (Fundação de Amparo a Pesquisa do Estado de Minas Gerais).*
[2] *Departamento de Zootecnia da Universidade Federal dos Vales do Jequitinhonha e Mucuri.*

ABSTRACT - This work aimed at determining the influence of roughage proportions and fat source of the diet on characteristics of carcass and comercial cuts of lambs. It was used 24 non-castrated Santa Inês male lambs, ad libitum fed diet with two proportions of roughage (30 and 70%) and fat (no fat, protected fat, and soybean) slaughtered at an avarage body weight of 35.4 kg (± 1.5 kg). Animals fed 30% roughage diet showed the highest weights and carcass yields. The percentages of posterior arm and ham were higher in animals fed 30% roughage with no addition of fat source. Total leg length and internal length were higher in animals fed 70% roughage diet while leg width was higher for those fed 30% roughage diet. Addition of fat source in diets with high percentage of concentrate can increase carcass yields. This effect is higher when protected fat is used regarded to whole soybean. Although diets do not have effect on most of these cuts, the effect on the ham confirms the influence of the diet on this noble cuts.

Key Words: nutrition, ovine meat, performance, protected fat, soy bean

Características da carcaça e dos cortes de cordeiros Santa Inês alimentados com rações com diferentes proporções de volumoso e fontes de gordura

RESUMO - Objetivou-se determinar a influência da proporção volumoso e da fonte de gordura da dieta sobre as características de carcaça e os cortes comerciais de cordeiros. Utilizaram-se 24 cordeiros Santa Inês machos não-castrados, recebendo, à vontade, dieta com duas proporções de volumoso (30 e 70%) e de gordura (sem gordura, gordura protegida e grão de soja) e abatidos com peso corporal médio de 35,4 kg (± 1,5 kg). Os animais alimentados com dietas com 30% de volumoso apresentaram os maiores pesos e rendimentos de carcaça. As porcentagens de braço posterior e pernil foram maiores nos animais que receberam a dieta com 30% de volumoso sem adição de fonte de gordura. O comprimento total de perna e o comprimento interno foram maiores nos animais que receberam a dieta com 70% de volumoso, enquanto a largura de perna foi maior naqueles alimentados com a dieta com 30% de volumoso. A adição de fonte de gordura em dietas com alta porcentagem de concentrado pode aumentar os rendimentos de carcaça. Esse efeito é maior quando utilizada gordura protegida em relação ao grão de soja integral. Apesar de as dietas não terem efeito na maioria dos cortes, o efeito sobre o pernil confirma a influência da dieta sobre esse corte nobre.

Palavras-chave: carne ovina, desempenho, gordura protegida, grão de soja, nutrição

Introduction

Nowadays, the main purpose of the Brazilian sheep breeding is meat production. However, the quality of the product is still an obstacle to ovine meat conquers a stable market. The nutritional management of the animal can interfere on the quality of this meat and on other factors such as weight and carcass yield and on retail cuts, which are extremely important factors to measure the capacity of the animal to produce meat (Alves et al., 2003). The carcasses can be marketed as a whole or as cuts. The individualized cuts associated to the product presentation are important in the commercialization because they provide the obtaition of differentiated prices allowing rational use, avoiding waste (Silva Sobrinho & Silva, 2000), and the yield of these cuts is an important index for quality evaluation. The importance of evaluation of the carcass measures is that according to El Karin et al., (1988), when combined with the carcass weight, they satisfactorily predict composition in muscle, fat and bone. According to Garcia et al. (2003), the studies on carcasses have the purpose of evaluating subjective and objective parameters, since they are related

Received October 31, 2008 and accepted September 8, 2009.
Corresponding author: iraides@dzo.ufla.br

with qualitative and quantitative aspects of the same. In this context, the area of loin eye is considered a measure that represents the amount and distribution of the muscular masses (Bonifacino et al., 1979).

According to Bendahan (2008), the management in feedlot is the best in order to reach larger productivity, and factors as rate of completion, food conversion, quality of the available animals, price and quality of food, consuming market of quality meat should be taken into account for the producer achieves a better economic return in the activity. The inclusion or not of fat sources in diet can commit the animal performance, because polyunsaturated fatty acids of long free chain are potentially poisonous to rumen microorganisms, damaging mainly the diets with high fiber proportions (Gibb et al., 2005). The objective of the present work was to evaluate carcass characteristics and retail cuts of Santa Inês lambs, fed in feedlots with diets containing or not different fat sources, whole soybean and protected fat.

Material and Methods

The experiment was carried out in Fazenda Experimental do Moura, Curvelo-MG, Setor de Ovinos of the Departamento de Zootecnia, of Universidade Federal dos Vales do Jequitinhonha e Mucuri. It was evaluated 24 Santa-Inês male lambs, weaned at 10 kg of average body weight. After weaning, they were kept in groups in feedlots until reaching 15 kg of body weight at an average age of 121 days (±13.06 days), when they were sent to the individual feedlot and randomly distributed to each one of the treatments. The following experimental diets were given once a day *ad libitum*: two roughage: concentrated proportions (70:30 and 30:70%, respectively). Tifton hay (*Cynodom sp*) was used as roughage, and the concentrate with or without inclusion of fat source consisted of ground whole soybean or protected fat - calcium soaps (Table 1). The presented food and leftovers were daily weighed, fixing 20% of leftovers. From the beginning of the confinement, the lambs were weighed weekly for monitoring body weight gain until they reached slaughter weight (35.4 kg).

The diets presented an average of 15.11% for crude protein, and 2,399.11 kcal/kg of dry matter for metabolizable energy, calculated according to NRC (1985) for lambs with weight gains of 295 g/day.

The animals were slaughtered after aproximately 14 hours of fasting of solids. They were eviscerated and later, the carcass were weighed and taken for cooling in a cold storage chamber (from 2 to 4ºC) for 24 hours, when it was removed and the weight of cold carcass was taken. The

Table 1 - Composition of ingredients and nutrients of experimental diets

	Diets - Roughage:concentrated (%)					
	30:70	30:70	30:70	70:30	70:30	70:30
	Fat source					
	Without addition	Protected fat	Integral soy	Without addition	Protected fat	Integral soy
Ingredient (%)						
Tifton hay	30.00	30.00	30.00	70.00	70.00	70.00
Crushed soybean	51.60	42.00	46.10	18.20	2.70	6.50
Soy bran	16.50	22.00	0.00	9.50	21.00	0.00
Protected fat[4]	0.00	5.00	0.00	0.00	5.00	0.00
Integral soybean	0.00	0.00	22.00	0.00	0.00	22.00
Limestone	0.90	0.00	0.90	0.40	0.00	0.50
Urea	0.00	0.00	0.00	0.80	0.00	0.00
Phosphoric acid	0.00	0.00	0.00	0.10	0.30	0.00
Mineral/vitaminic premix	1.00	1.00	1.00	1.00	1.00	1.00
Nutrient						
Crude protein (%)[1]	12.74	11.93	1085	8.61	12.83	13.92
Neutral detergent fiber (%)[2]	51.32	57.73	56.37	43.67	44.55	38.02
Acid detergent fiber (%)[2]	14.51	15.91	15.30	30.22	28.46	26.23
Cell content (%)[2]	48.68	42.27	43.63	56.33	55.45	61.98
Hemicellulose (%)[2]	36.82	41.83	41.06	13.45	16.08	11.79
Ashs (%)[1]	4.76	5.22	4.80	6.18	6.82	6.50
EM (kcal/kg)[3]	2.56	2.78	2.61	2.06	2.27	2.12
Ethereal extract (%)[3]	2.89	6.74	6.57	2.45	6.19	6.03
Calcium (%)[3]	0.51	0.63	0.52	0.48	0.79	0.54
Phosphorus (%)[3]	0.28	0.29	0.29	0.24	0.32	0.26

[1]Quantified according to AOAC methodology (1990).[2]Quantified according to Silva methodology (1981); [3]Calculated according to composition of ingredients on NRC Table (1985); [4]Calcium soaps - composition presented by the supplying company of the product.

weight of hot and cold carcass was used in relation to slaughter weight to calculate their yield. It was also calculated the real yield obtained from the empty weight of each animal, in other words, heavy digestive contents discounted after evisceration.

After the carcass removal from the cold storage chamber, the following carcass measures were taken according to Fisher & Boer (1994): total length (distance from the base of the tail to the base of the neck); subcutaneous fat (taken from the 12^{th} to the 13^{th} rib); croup width (maximum width between the trochanters of both femurs); croup perimeter (perimeter of this area, referenced by the trochanters of both femurs). Next, the carcass was longitudinally divided into two equal parts. Internal length (maximum distance between previous board of the ischium-pubic symphysis and previous board of the 1^{st} rib), leg length (distance between fibula and previous board of tarsal metatarsal articulation), and thorax depth (maximum width between breastbone and back) were measured in the left half carcarss according to Fisher & Boer (1994). The area of *longissimus dorsi* (loin eye) muscle was measured through transparent standard form squared (1 cm^2/cell), adapted from Cunha et al. (2001) and thickness of subcutaneous fat was measured in the cut made between the 12^{th} and 13^{th} ribs.

After the removal of the tail, kidneys and perirenal and cavity fats, the left half carcass was subdivided into the following retail cuts: leg, loin, shoulder, chop, rib/belly, previous arm, subsequent arm and neck, as described by Furusho-Garcia et al. (2004), and they were weighed for calculation of proportions (% in relation to cold carcass weight).

The data were analyzed in SAS program (SAS, 1991). The experimental design was entirely randomized in a 2 × 3 factorial outline (two roughage: concentrated proportions and three fat sources), with four repetitions for diet. The averages were compared by Tukey's test at 5% of significance.

Results and Discussion

The animals fed 30% of roughage diet presented greater weights and yields of hot and cold carcass when compared to individuals fed larger roughage proportion, a result that was already provided once diets with larger concentrate proportion usually make available more metabolizable energy which provides larger muscular mass growth and adipose tissue that compose the carcass (Table 2).

However, there was no effect (P>0.05) of roughage proportion under the real yield of cold carcass, what can be explained by a significant difference in weight and proportion (in relation to slaughter weight) of digesting content among animals consuming different diets, in which those that consumed diets with 70% of roughage presented content weight of 6.80 kg (19.22%) compared to 5.02 kg (14.17%) of those that consumed diets with 30% of roughage.

For both of hot and cold carcass weights, their yield and slaughtered weight showed inherence to addition of fat source in the diets of Santa Inês lambs corroborating with the results found by Urano et al. (2006), who working with

Table 2 - Means of the percentages (%) and weights (kg) of retail cuts of Santa Inês lambs in function of roughage proportion and fat source *

	Roughage proportion: concentrated					
Fat source	30:70	70:30	Mean	30:70	70:30	Mean
	Hot carcass weight			Cold carcass weight		
Without fat	16.23	16.00	16.11a	15.46	15.48	15.47a
With protected fat	17.49	15.60	16.54a	16.93	15.40	16.16a
With integral soybean	17.23	15.45	16.34a	16.88	14.93	15.90a
Mean	16.98A	15.68B	16.33	16.43A	15.27B	15.84
	Hot carcass yield			Cold carcass yield		
Without fat	46.04	44.77	45.41a	43.94	43.29	43.62a
With protected fat	50.60	43.96	47.28a	48.98	43.38	46.18a
With integral soybean	47.49	44.31	45.90a	46.52	42.82	44.67a
Mean	48.05A	44.35B	46.20	46.48A	43.17B	44.82
	Cold carcass true yield			Slaughter weight		
Without fat	51.38	53.57	52.48a	37.10	37.38	37.36a
With protected fat	55.58	54.47	55.02a	36.56	38.05	37.31a
With integral soybean	55.48	52.48	53.98a	37.33	37.40	37.24a
Mean	54.15A	53.50A	53.83	36.99A	37.61A	37.30

* Means followed by different letters, capital letter in lines and small letters in columns, differ P<0,05 by Tukey's test, comparing roughage or fat source, or differ by t test when the interaction was significant.

Santa Inês ovines fed different levels of soybean (0, 7, 14, 21%) did not find differences among diets for hot and cold carcass yield, whose observed averages were 48.9 and 47.7%, respectively.

Significant differences were not observed (P>0.05) for carcass length, leg length, croup width, croup circumference and subcutaneous fat regardless to the addition of fat source and roughage proportions adopted in this study.

Considering the total leg length and internal length, it was observed that the group of animals that received diet containing 30% of roughage presented lower values for these measures, the ones which were not influenced by the addition of fat source. When the leg width was evaluated, it was observed that its measure (10.17 cm) was higher for lambs fed 30% roughage compared with animals that received 70% of hay (9.40 cm). These results provide an indicative that carcass of lambs that receive smaller roughage proportion in diet present larger compactness of the leg, provided by the largest energy intake of diets composed by ingredients with better advantages, mainly in rumen, favoring higher muscular mass growth concerning to bone tissue.

The loin eye area presented significant interaction (P<0.05) between the fat source and roughage proportion of diet, and there was no significant difference in diets without addition of independent fat source of roughage proportion. When fat was added into the diet, it was verified that the protected fat provided larger loin eye area (2463 mm^2) in diet with smaller roughage:concentrated relationship whereas the addition of soybean as fat source increased loin eye area in the diet with 70% of roughage. That result could be explained by some interaction between the diet ingredients after the addition of different fat sources. The inclusion of fat source in diet with smaller roughage:concentrate relationship increases its energy content more, providing animal tissue development. However, for diets with greater roughage:concentrate relationship, despite of elevating the energy density, the fat reduces the forage digestibility, which did not happen when soybean was used. However, when evaluating the average results for loin eye area obtained by ultrasound scanning before slaughter, it was observed that there were no differences among diets.

When evaluating the neck weight of animals that did not receive fat source, it was larger (P<0.05) for higher roughage proportion, with no differences in the percentage of this cut. With the use of protected fat, much weight as neck percentage in relation to cold carcass was larger in 30% roughage diets. The results indicate that this cut is markedly influenced by nutritional management maybe because this cut presents high fat proportion, a tissue that is easily affected by the nutrients.

The results showed that the rib/belly was influenced (P<0.05) by the addition of fat source in diet, but not by the roughage proportion, and the use of protected fat promoted larger weight and cut percentage when compared to animals that received soybean as fat source.

For the ham, which is a noble cut, the weight was smaller in lambs that received diets containing larger roughage tenor, while the addition of fat source did not influence this cut. However, the percentage of this cut in relation to cold carcass presented interaction between fat source and roughage proportion, and, in diets without fat source, the ham weight was larger for 30% of roughage. There was no variation (P>0.05) between the relationship roughage:concentrated when fat source was used, regardless to the source. For animals that received larger proportions of concentrate and did not receive fat sources, they presented a higher ham proportion. The results are in disagreement with Yamamoto et al. (2004) who evaluated

Table 3 - Measurements averages of carcasses (cm) of Santa Inês ovines in function of the roughage proportion and fat source *

Treatments**	Roughage:concentrate		Fat source		
	30:70	70:30	Without fat	With protected fat	With whole soy bean
Carcass length (cm)	51.94A	50.81A	52.56a	51.00a	50.56a
Internal length (cm)	62.74B	65.94A	64.25a	63.26a	65.51a
Thorax depth (cm)	27.21A	27.45A	26.55b	27.47ab	27.96a
Leg length (cm)	25.37A	25.63A	25.01a	25.64a	25.86a
Croup width (cm)	20.47A	21.18A	20.45a	21.30a	20.74a
Total leg length (cm)	40.42B	45.03A	41.96a	42.97a	43.24a
Leg widhth (cm)	10.17a	9.40B	10.17A	9.80a	9.27a
Croup circumference (cm)	59.67A	59.73A	59.75a	59.22a	60.12a
Subcutaneous fat (cm)	2.54A	3.03A	3.01a	2.45a	2.90a
Loin eye are by ultrasound (mm^2)	891A	842A	896a	859a	845a

* Means followed by different letters, capital letters or small letters in columns, differ by Tukey test, (P<0.05) for roughage: concentrated and fat source, respectively.**

Table 4 - Measurement of the loin eye area of Santa Inês ovines in function of roughage proportion and fat source *

	Roughage proportion: concentrated		
Fat source	30:70	70:30	Mean
Without fat	1857Aa	1677Ab	1767
With protected fat	2463Aa	1360Bb	1911
With integral soybean	1820Ba	2766Aa	2293
Mean	2046	1934	1990

* Means followed by different letters, capital letters in lines and small letters in columns, differ by t test (P<0.05).

the inclusion of fat sources (soybean oil, canola and linseed) in rations for Santa Inês purebreed lambs and Santa Inês x Dorset crossbreed, slaughtered at 30 kg of body weight, at an average age of 150 days, and differences were not observed for leg yield.

For the shoulder, carré, loin and anterior arm, there was no influence of diets on their weights and proportions. These results corroborate with Urano et al. (2006) who

Table 5 - Means of percentages (%) and weights (kg) of retail cuts of Santa Inês lambs in function of roughage proportion and fat source

	Roughage proportion: concentrated					
Fat source	30:70	70:30	Mean	30:70	70:30	Mean
	Neck weight			Neck percentage		
Without fat	1.51Ba	1.66Aa	1.58	9.73Aa	10.77Aa	10.25
With protected fat	1.75Aa	1.38Bb	1.56	10.37Aa	9.00Ba	9.68
With integral soybean	1.60ABa	1.65Aa	1.62	9.47Ab	11.03Aa	10.26
Mean	1.62	1.56	1.59	9.86	10.27	10.06
	Rib/belly weight			Rib/belly percentage		
Without fat	1.50	1.35	1.42ab	9.68	9.45	9.20ab
With protected fat	1.60	1.46	1.53a	9.48	8.72	9.47a
With integral soybean	1.45	1.25	1.35b	8.59	8.39	8.49b
Mean	1.52A	1.35A	1.43	9.25A	8.85A	9.05
	Ham weight			Ham percentage		
Without fat	2.19	2.00	2.09a	14.12Aa	12.97Ba	13.54
With protected fat	2.08	1.99	2.04a	12.31Ab	12.96Aa	12.63
With integral soybean	2.18	1.98	2.08a	12.91Ab	13.23Aa	13.07
Mean	2.15A	1.99B	2.07	13.11	13.05	13.08
	Loin weight			Loin percentage		
Without fat	0.53	0.55	0.54a	3.43	3.54	3.48a
With protected fat	0.53	0.50	0.52a	3.12	3.26	3.19a
With integral soybean	0.54	0.46	0.50a	3.19	3.07	3.13a
Mean	0.53A	0.50A	0.52	3.25A	3.29A	3.27
	Shoulder weight			Shoulder percentage		
Without fat	1.15	1.13	1.14a	7.42	7.27	7.35a
With protected fat	1.18	1.12	1.15a	6.95	7.24	7.09a
With integral soybean	1.24	1.13	1.18a	7.36	7.58	7.47a
Mean	1.19A	1.12A	1.16	7.24A	7.36A	7.30
	Carré weight			Carré percentage		
Without fat	1.08	1.12	1.10a	6.94	7.21	7.07a
With protected fat	1.18	1.05	1.12a	6.95	6.83	6.89a
With integral soybean	1.26	0.97	1.11a	7.44	6.54	6.99a
Mean	1.17A	1.05A	1.11	7.11A	6.86A	6.98
	Anterior arm weight			Anterior arm percentage		
Without fat	0.26	0.25	0.26a	1.68	1.62	1.65a
With protected fat	0.25	0.25	0.25a	1.46	1.64	1.55a
With integral soybean	0.27	0.24	0.25a	1.58	1.59	1.59a
Mean	0.26A	0.25A	0.25	1.58A	1.62A	1.60
	Posterior arm weight			Posterior arm percentage		
Without fat	0.34	0.30	0.33a	2.20Aa	1.92Ba	2.06
With protected fat	0.32	0.30	0.31a	1.86Ab	1.94Aa	1.90
With integral soybean	0.33	0.30	0.31a	1.94Ab	2.03Aa	1.98
Mean	0.33A	0.30B	0.31	2.00	1.96	1.98

[1] Means followed by different letters, capital letter in lines and small letters in columns, differ among themselves by Tukey's test, P<(0.05), in means comparing roughage or fat source, or differ between themselves by t test when the interaction was significant.

evaluated the performance and carcass characteristics of confined lambs fed soybeans in growing levels (0, 7, 14, 21%) and did not find difference among diets in the yield of retail cuts of Santa Inês lambs; and with Yamamoto et al. (2004) who did not observe difference in the yield of loin and shoulder.

Although the weights of cuts differed according to the diet (Table 5), in many cases yield did not differ significantly. This tendency can be explained by the law of harmony anatomical described by Boccard & Dumont (1960), because in agreement with these authors, carcasses with similar weights and amounts of fat means that all body areas are in similar proportions, whatever the genotype frame is.

Conclusions

The yield and carcass weights of Santa Inês lamb reared in feedlot decreases when the roughage proportion goes from 30 to 70%, but the same ones are not affected by the use of protected fat or whole soybean as fat source. The leg, a noble cut, present in higher proportion in carcass of lambs that are fed diets without fat source and with larger concentrate proportion.

References

ALVES, K.S.; CARVALHO, F.F.R.; FERREIRA, M.A. et al. Níveis de energia em dietas para ovinos Santa Inês: características de carcaça e constituintes corporais. **Revista Brasileira Zootecnia**, v.32, n.6, p.1927-1936, 2003.

ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTS - AOAC. **Official methods of analysis**. 15.ed. Arlington, 1990. v.1. 1117p.

BENDAHAN, A.B. [2008] **Confinamento de cordeiros**: uma alternativa na ovinocultura. Disponível em: <http:// www.agroline.com.br/ artigos/artigo.php?id=304>. Acesso em: 11/3/2008.

BOCCARD, R.; DUMONT, B.L. Etude de la production de la viande chez les ovins. II. Variation de l'importance relative des differentes régions corporelles de l'agneaus de boucherie. **Annales de Zootechnie**, v.9, n.4, p.355-365, 1960.

BONIFACINO, L.; KREMER, R.; ORLANDO, D. et al. Estudio comparativo de corderos Corriedale y Corriedale por Texel. Pesos al nascer, ganancias diarias y caracteristicas de la carcaça. **Revista Veterinária**, v.70, p.63-71, 1979.

CUNHA, E.A.; BUENO, M.S.; SANTOS, L.E. et al. Desempenho e características de carcaça de cordeiros Suffolk alimentados com diferentes volumosos. **Ciência Rural**, v.31, n.4, p.671-676, 2001.

EL KARIN, A.I.A.; OWEN, J.B.; WHITAKER, C.J. Measurement on slaughter weight, side weight, carcass joints and their association with carcass composition of two types of Sudan Desert sheep. **Journal of Agricultural Science**, v.110, n.1, p.65-69, 1988.

FISHER, A.V.; BOER, H. The EAAP standard method of sheep carcass assessment. Carcass measurements ans dissection procedures. Report of the EAAP Working Group on Carcass Evaluation, in cooperation with the CIHEAM, Agronomic Institute Mediterraneo of Zaragoza and the CEC Directorate General for Agriculture in Brussels. **Livestock Production Science**, v.38, n.2, p.149-159, 1994.

FURUSHO-GARCIA, I.F.; PEREZ, J.R.O.; BONAGURIO, S. et al. Desempenho de cordeiros Santa Inês puros e cruzas Santa Inês com Ile de France e Bergamácia. **Revista Brasileira de Zootecnia**, v.33, n.6, p.1591-1603, 2004.

GARCIA, C.A.; MONTEIRO, A.L.G.; COSTA, C. et al. Medidas objetivas e composição tecidual da carcaça de cordeiros alimentados com diferentes níveis de energia em creep feeding. **Revista Brasileira de Zootecnia**, v.32, n.6, p.1380-1390, 2003

GIBB, D.J.; SHAH, M.A.; MIR, P.S. et al. Effect of full-fat hemp seed on performance and tissue fatty acids of feedlot cattle. **Canadian Journal of Animal Science**, v.85, p.223-230, 2005.

NATIONAL RESEARCH COUNCIL - NRC. **Nutrient requirements of sheep**. 6.ed. Washington, D.C.: NAS, 1985. 99p.

STATISTICAL ANALYSIS SYSTEM - SAS. **SAS/STAT**: user´s guide version 6, 4.ed. Cary: 1991. 956p.

SILVA, S.S. **Análise de alimentos** (métodos químicos e biológicos). 2.ed. Viçosa, MG: UFV, 1981. 166p.

SILVA SOBRINHO, A.G.; SILVA, A.M.A. Produção de carne ovina – Parte II. Artigo técnico. **Revista Nacional da Carne**, v.286, p.30-36, 2000.

URANO, F.S.; PIRES, A.V.; SUSIN, I. et al. Desempenho e características da carcaça de cordeiros confinados alimentados com grãos de soja **Pesquisa Agropecuária Brasileira**, v.41, n.10, p.1525-1530, 2006.

YAMAMOTO, S.M.; MACEDO, F.A.F.; MEXIA, A.A. et al. Rendimentos dos cortes e não componentes das carcaças de cordeiros terminados com dietas contendo diferentes fontes de óleo vegetal. **Ciência Rural**, v.34, n.6, p.1909-1913, 2004.