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Carcass and meat traits of lambs fed by-products from the processing of oil seeds

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ABSTRACT. We evaluated the effect of adding by-products from the processing of oil seeds in the diet of lambs on the carcass and meat traits. Twenty-four non-castrated weaned male Santa Inês lambs with approximately 70 days of age and initial average weight of 19.11 ± 2.12 kg were distributed into a completely randomized design. Treatments consisted of diets containing by-products with 70% of concentrate and 30% of tifton hay (*Cynodon spp.*) and were termed SM: control with soybean meal; SC: formulated with soybean cake; SUC: formulated with sunflower cake and PC: formulated with peanut cake. Diets had no effects on the carcass traits evaluated. There was no significant effect on the mean values of perirenal, omental and mesenteric fats (0.267, 0.552 and 0.470 kg, respectively) and there was no influence on the percentages of moisture, ether extract, crude protein or ash in the loin between experimental diets. Diets containing by-products from the processing of oil seeds did not change fatty acids found in lamb meat. The use of by-products from oil seeds provided similar carcass and meat traits, thus their use can be recommended as eventual protein and energy sources for feedlot lambs.

Keywords: peanut cake, protein, soybean cake, sunflower cake, yield.

Características da carcaça e da carne de cordeiros alimentados com subprodutos de oleaginosas

RESUMO. Avaliou-se o efeito da adição de subprodutos oriundos do processamento de oleaginosas na dieta de cordeiros sobre as características da carcaça e da carne. Foram confinados 24 cordeiros machos não-castrados, da raça Santa Inês, desmamados com aproximadamente 70 dias de idade, peso médio inicial de 19,11 ± 2,12 kg, distribuídos em delineamento inteiramente casualizado. Os tratamentos consistiram de dietas contendo subprodutos, com 70% de concentrado e 30% de feno de tifton (*Cynodon spp.*), denominadas FS: controle com farelo de soja; TS: formulada com torta de soja; TG: formulada com torta de girassol e TA: formulada com torta de amendoim. Para as características da carcaça não houve influência das dietas sobre as variáveis analisadas. Não houve efeito para os valores médios dos depósitos de gorduras perirrenal, omental e mesentérica, (0,267; 0,552 e 0,470 kg), respectivamente. Não houve influência nas percentagens de umidade, extrato etéreo, proteína bruta e cinzas do lombo entre as dietas experimentais. As dietas contendo subprodutos de oleaginosas não proporcionaram alteração nos ácidos graxos da carne dos cordeiros. A utilização dos subprodutos de oleaginosas proporcionou características da carcaça e da carne semelhantes podendo-se recomendar sua utilização como eventuais fontes proteicas e energéticas para cordeiros em confinamento.

Palavras-chave: torta de amendoim, proteína, torta de soja, torta de girassol, rendimento.

Introduction

Beef is a protein-rich food and is one of the main nutrient sources for humans, since it consists of edible muscle, connective tissue and associated fat. The most important meat quality attributes include tenderness, taste, juiciness, leanness, nutrient quantities, safety and convenience (WEBB, 2006). However, there is great variation in the chemical and physical components of beef, which can be attributed to factors such as the breed, sex, and age of the animals, nutrition and anatomical position of the cut (ROTTA et al., 2009). The evaluation of the meat quality by consumers begins with the color of meat and amount of fat coverage, followed by processing aspects, such as fluid loss during thawing and cooking, and tenderness, which is considered the most important qualitative aspect of beef (KOOHMARAIE et al., 2002). Currently, there is a concern with human nutrition and the sanitary quality of food and, more importantly, the possible effects (harmful or beneficial) of certain foods or nutrients on consumer health.

Research institutions, consequently, seek to study factors related to the changes that occur in the desirable features of the meat and the possible causes of these changes (IGARASI et al., 2008).

When introducing a new ingredient to the diet of the animals, besides the acceptability and quality in chemical composition, it is important to observe that this promotes development of animal body as well as the sensory chemical and nutritional characteristics of meat produced.

Currently it is known that it is possible, through nutrition, to modify carcass characteristics and, mainly, of ruminant meat (SCOLLAN et al., 2006). In this sense many studies are developed with the aim at obtaining a final product healthier for human consumption, or at least that does not bring damage to nutritional value of meat produced in feedlot systems, which adopts the inclusion of agroindustrial by-products in their diets.

The energy level of the diet has great importance since the deposition of body fat promotes differences in the quantity and quality of the carcass. It is worth emphasizing that the use of lipid sources in the diet of ruminants has been adopted in order to provide high energetic density to increase rates of weight gain of the animals and improve the carcasses (OLIVEIRA et al., 2007).

Introducing cakes in animal diets has proven to be a feasible feeding alternative that brings good results (SANTOS et al., 2009, 2012). They have a high potential, given their significant concentrations of protein and ether extract, which make their protein and/or energy levels capable of meeting the nutritional requirements of these fractions for animals. Thus, the objective of this study was to study the inclusion of alternative protein sources originated from the processing of oil seeds intended for production of biodiesel in the carcass and meat traits of feedlot lambs.

Material and methods

The experiment was conducted at the Animal Unit for Digestive and Metabolic Studies of the Department of Animal Science of the Faculty of Agricultural and Veterinary Sciences in UNESP, Campus Jaboticabal, São Paulo State, Brazil.

Four isonitrogenous and isocaloric diets (18% of CP in DM and 2.52 ME Mcal kg^{-1} DM) were formulated (NRC, 2007) with a forage: concentrate ratio of 30:70, using ground tifton hay *(Cynodon spp.)* as forage (Table 1).

Twenty-four non-castrated weaned male Santa Inês lambs with approximately 70 days and initial average weight of 19.11 ± 2.12 kg were confined. To control development, lambs were weighed every 14 days and then weekly after the first animals were slaughtered, upon reaching approximately 32 kg. The feedlot time was approximately 55 days. Animals were weighed and restricted to a fluid diet for 16 hours. Animals were stunned by an electric shock of 220 V for 8 seconds and immediately bled, by sectioning the jugular veins and carotid arteries after stunning.

Just before the slaughter, animals were again weighed (slaughter weight) and the percentages of weight loss during fasting were determined. After slaughtering, the gastrointestinal tract was emptied for calculation of empty body weight (slaughter weight minus the weight of the gastrointestinal tract, after being weighed full and empty), to determine the real carcass yield (ratio between hot carcass weight and empty body weight). Deposits of perirenal, omental and mesenteric fat were weighed.

Table 1. Percentage of ingredients and chemical composition and energy of experimental diets (% DM).

	Diets			
Ingredients (%)	SM[1]	SC[2]	SUC[3]	PC[4]
Tifton hay	30.00	30.00	30.00	30.00
Corn grain	45.40	45.40	45.40	45.40
Soybean meal	23.00	14.00	14.00	14.00
Soybean cake	-	9.00	-	-
Sunflower cake	-	-	9.00	-
Peanut cake	-	-	-	9.00
Antioxidant	0.10	0.10	0.10	0.10
Limestone	0.50	0.50	0.50	0.50
Mineral mixture*	1.00	1.00	1.00	1.00
Total	100.00	100.00	100.00	100.00
Composition (%DM)				
Crude protein	18.72	18.04	18.00	18.26
Ether extract	2.82	3.92	4.01	4.04
Neutral detergent fiber	38.24	39.06	43.97	39.82
ME (Mcal Kg^{-1} DM) **	2.51	2.53	2.51	2.52

[1]SM: control with soybean meal; [2]SC: formulated with soybean cake; [3]SUC: formulated with sunflower cake; [4]PC: formulated with peanut cake. Commercial mineral mixture for sheep (P = 60 g; Ca = 100 g; Na = 195 g; Mg = 10 g; S = 25 mg; Zn = 4.000 mg; Cu = 600 mg; Mn = 600 mg; Fe = 1.200 mg; Co = 100 mg; I = 180 mg; Se = 12 mg; Fl (maximum) = 600 mg). ** ME = 0.82 DE (Sniffen et al., 1992)

After evisceration, carcasses were weighed (hot carcass weight) and transferred to a cold chamber at

4ºC, for 24 hours. At the end of this period, cold carcasses were weighed, so the percentages of loss by cooling and the cold carcass yield (ratio between cold carcass weight and slaughter weight, expressed in percentage) could be calculated. To determine the compactness index, were measured: leg length, internal carcass length and croup width. The carcass compactness (cold carcass weight divided by the internal carcass length) and leg compactness (croup width divided by leg length) indices were calculated, according to (SAÑUDO, 2008)

Subsequently, carcasses were divided lengthwise into two half-carcasses; the left half was sectioned into five anatomical regions: shoulder, neck, ribs, loin and leg, which were weighed separately, to determine the percentages that they represented in relation to the cold half-carcass. A transversal cut was made, exposing the *longissimus lumborum* muscle at the 13th thoracic vertebrae, for evaluation of the subcutaneous thickness, with the aid of a caliper for measurements for the calculation of the loin-eye area. The latter consists of three measures: A (maximum length of the muscle); B (maximum depth of the muscle); and C (backfat thickness of the muscle). The loin-eye area was calculated by the formula $(A/2 \times B/2)\ \pi$, according to (SILVA SOBRINHO et al., 2002).

We collected a sample of the loin, of which all subcutaneous fat was removed so as to analyze the cholesterol and long-chain fatty acid contents of the meat.

Samples of the loins of all left half-carcass were collected for lyophilization for 72 hours. Samples were weighed before and after lyophilization for subsequent determination of the 1st DM. Next, the contents of ether extract (EE), crude protein (CP) and ash (ASH) were determined according to the AOAC (1995).

The amount of cholesterol in the meat was determined according to the methodology of Bohac et al. (1988), by which 10 grams of raw meat were subjected to lipid extraction with chloroform: methanol (2:1). Then, an aliquot of 5 mL chloroform extract was evaporated with nitrogen gas and subjected to saponification with a solution of potassium hydroxide in ethanol 12%. The unsaponifiable fraction (cholesterol) was extracted with hexane, purified and subjected to color reaction with acetic and sulfuric acids, and ferrous sulfate as catalyst. Then was proceeded with a spectrophotometer at 490 nm. The calibration curve was drawn for cholesterol, using cholesterol pa 0.01 grams diluted in 50 mL de hexane, from which were withdrawn aliquots corresponding to 40, 80, 120, 160 and 200 mg mL^{-1}.

For the transesterification of fatty acids, the methodology described by Christie (1982) was used with modifications using a methanolic solution of sodium methoxide. The fatty acid methyl esters were separated in a 100 m capillary column with silica (SP-2560) fused with hydrogen as the carrier gas (1.8 mL min.$^{-1}$) and a flame ionization detector (FID). Each sample was rotated as described by Griinari et al. (1998), with a temperature gradient of 70 to 240°C for the identification of fatty acid peaks. After the identification of the peaks, a standard butter (CRM 164; Commission of the European Communities, Community Bureau of Reference, Brussels, Belgium) was used for the certification of the recovery of the fatty acids according to the peaks and retention times.

The statistical design adopted was completely randomized, with four diets and six replications. The results were subjected to analysis of variance. The statistical procedure PROC GLM (SAS, 2008) was used, and means were compared by Tukey's test, at 5% of probability.

Results and discussion

Diets had no influence on the carcass traits analyzed (Table 2); therefore, diets containing soybean, sunflower and peanut cakes provided similar carcass traits to those of the control diet. The ether extract content of diets containing by-products although numerically greater, were not enough to affect carcass traits.

Fat contains more energy than carbohydrates, therefore it is expected to increase the efficiency of utilization of feed consumed, when the concentration of the feed energy is increased, since the dry matter intake is not affected (GIBB et al., 2005). However, depending on the fat or fat source used, animal performance may be impaired, polyunsaturated fatty acids are long chain potentially toxic to rumen microorganisms, particularly the cellulolytic bacteria and protozoa (PALMQUIST; JENKINS, 1980), contributing to reduce microbial activity and subsequent digestion (GIBB et al., 2005).

However, no effects on yields and carcass weights were detected in various studies including the study of Santos et al. (2009) who also used Santa Inês lambs fed grain, meal and canola cake.

Differences in carcass yield are more commonly described in experiments conducted with various genetic types of sheep (ALMEIDA et al., 2009), which showed different tissue growth curves, and different slaughter and trim conditions.

Table 2. Mean values of carcass characteristics according to diet.

Variables	Diets				
	SM[1]	SC[2]	SUC[3]	PC[4]	CV (%)
Body weight (kg)	32.54	32.52	32.90	32.97	2.01
Slaughter weight (kg)	31.00	31.00	31.60	31.58	2.96
Empty body weight (kg)	27.09	27.23	27.16	27.75	3.67
Fasting weight loss (%)	4.76	4.66	3.95	4.21	40.48
Hot carcass weight (kg)	15.28	15.15	15.06	15.60	5.05
Cold carcass weight (kg)	15.02	14.95	14.80	15.37	5.04
Hot carcasss yield (%)	49.27	48.88	47.71	49.44	5.20
Cold carcasss yield (%)	48.44	48.23	46.89	48.70	5.41
Real yield (%)	56.42	55.64	55.48	56.20	3.65
Loss by cooling (%)	1.67	1.33	1.74	1.50	31.84
Rib eye area (cm^2)	12.77	12.18	11.16	12.55	15.80
Fat thickness (mm)	0.88	1.78	0.89	0.89	9.95
Carcass compactness index (kg cm^{-1})	0.26	0.25	0.25	0.25	7.50
Leg compactness index (cm)	0.62	0.65	0.60	0.62	11.40

CV = Coefficient of variation

The result observed for hot carcass yield and cold carcass yield was coherent, since the cooler shrinkage did not differ between the diets studied. We can affirm that the efficiency in the transformation of the feed consumed into body weight and carcass weight was similar, because there was no reduction in carcass yield in relation to body weight.

Hot and cold carcass yields averaged 48.9 and 47.7%, respectively. These results were similar to Palmieri et al. (2012), who evaluated inclusion levels of sunflower cake and observed no differences in carcass yields.

Considering all the diets, averaged real yield was 55.94%. This value can be considered good, and equivalent to those reported by Urano et al. (2006) which are appropriate results for Santa Inês lambs with initial body weight 19.5 kg and 75 days old fed raw soybean, which varied from 53 to 56%. Experimentally, the real yield is the most precise measure, because it does not include the digestive content (MACEDO et al., 2006).

No difference was observed in cooler shrinkage. According to Marques et al. (2007), in sheep, cooler shrinkage losses are usually around 2.5%, with possibility of variation between 1 and 7%, according to the relative humidity of the cold chamber. In this experiment, the average value of this variable was considered lower (1.56%) than the value found by Marques et al. (2007) in lambs slaughtered with body weight of 32 kg.

Rib eye area is a measurement that reflects the amount of carcass muscle, which was 12.17 cm^2 and was not influenced by the inclusion of by-products. Palmieri et al. (2012) found 14.8 cm^2 and 1.5 mm for rib eye area and fat thickness, respectively, in Santa Inês lambs fed increasing levels of sunflower cake, hence higher than those of the present study. Thus, it is possible to consider the rib eye area as adequate, given the carcass weight of the animals. No difference in rib eye area was found in this study; and according to Pereira Filho et al. (2008), animals of similar weight imply similar carcass weight and rib eye area.

The average fat thickness value obtained in this study was 1.1 mm and considered low; according to Silva Sobrinho et al. (2002) the average fat thickness varies from 2 to 5 mm and can be explained by the genetic group and by the fact that animals were young, averaging 130 days at slaughter. The fat from the diet tends to be deposited in the animal carcass, but this is highly variable, possibly being influenced by the type of fat, dry matter intake, physiological state and animal category. In this trial, once animals were in the growth phase or due to the type of diet or the short period in feedlot (54 days), this component was not excessively deposited in the carcass. Young animals tend to deposit and have less fat in the carcass. One should also consider that in the process of withdrawing from leather, it is possible that part of this fat had been removed from, remaining adhered to leather.

Mattos et al. (2006) reported that low carcass compactness values are not desirable from the quality perspective; hence the importance of producing heavier carcasses and from younger animals. Carcass compactness index and leg compactness index did not differ among experimental diets studied. Mean values for carcass compactness index (kg cm^{-1}) and leg compactness index (cm) were 0.25 and 0.62, respectively. These values are expressive, indicating a good deposition of muscle tissue per unit of length compared with those obtained in other studies using animals of the same genotype. The values for carcass compactness index and leg compactness index were higher than found by Carvalho et al. (2005) 0.20 kg cm^{-1} and Santos et al. (2009) 0.58, respectively.

Relative growth of tissues follows the law of anatomical harmony, obeying the following chronological order: bone, muscle and fat (pelvic-renal and subcutaneous), and fat deposition increases with age and type feeding the lambs (LOUVANDINI et al. 2007). High concentrate diets determine greater availability of energy and favor the growth of adipose tissue, reducing the yield of edible portion.

However, with 70% of concentrate herein, there was no significant effect ($p > 0.05$) for the mean values of perirenal, omental and mesenteric fats (0.267, 0.552 and 0.470 kg), respectively (Table 3).

Similar values of perirenal and omental fats of 250 and 512 g were verified by Clementino et al. (2007) in lambs fed diets containing 75% concentrate.

Table 3. Perirenal, mesenteric and omental fat weight, according to diets.

	Diets				
Variables (kg)	SM[1]	SC[2]	SUC[3]	PC[4]	CV (%)
Perirenal fat	0.299	0.308	0.255	0.204	21.57
Omental fat	0.584	0.548	0.510	0.564	14.50
Mesenteric fat	0.424	0.502	0.502	0.452	13.87

[1]SM: control with soybean meal; [2]SC: formulated with soybean cake; [3]SUC: formulated with sunflower cake; [4]PC: formulated with peanut cake. CV = Coefficient of variation

No influence of diets could be observed on the yield of carcass cuts. Cuts like shoulder, ribs and legs were those presenting the highest yields in relation to the cold carcass weight (Table 4). This can be explained by the larger amount of muscle tissue that these cuts have as compared with others. These results can be because animals were slaughtered at similar body weights, which corroborate Yamamoto et al. (2004), who stated that when carcasses present similar weight and fat content, almost all of the regions of the body have similar proportions, regardless of the breed.

Table 4. Yield of carcass cuts of lambs according to the experimental diets.

	Diets				
Variables (%)	SM[1]	SC[2]	SUC[3]	PC[4]	CV (%)
Neck	9.94	10.02	9.27	9.84	9.23
Shoulder	18.88	18.54	19.46	18.41	4.96
Rib	26.87	26.39	25.13	26.91	5.47
Loin	11.17	11.64	12.82	11.65	10.56
Leg	33.21	33.19	33.34	33.15	4.54

[1]SM: control with soybean meal; [2]SC: formulated with soybean cake; [3]SUC: formulated with sunflower cake; [4]PC: formulated with peanut cake. CV = Coefficient of variation

Experimental diets had no influence on the proximate composition in the muscle, which indicates that inclusion of by-products of oil seeds to lamb diets did not affect the muscle proximate composition (Table 5). According to Madruga et al. (2006), the proximate composition of sheep meat presents mean values of 75% moisture, 19% protein, 4% ether extract and 1.1% mineral matter. The proximate composition values found in this study are in accordance with the aforementioned values, except for crude protein, which was higher because of the variation of this fraction as a function of slaughter weight and the muscle used in the analysis. However, the chemical composition is similar to values presented in other trials with Santa Inês lambs (SANTOS et al., 2009), showing that the by-products from the processing of oil seeds can be used for replacing energy ingredients with no damage to the value nutritional of the meat, indicating that it was produced with good quality.

Table 5. Proximate composition of the carcass loin of feedlot lambs.

	Diets				
Components	SM[1]	SC[2]	SUC[3]	PC[4]	CV (%)
Moisture	73.53	75.25	76.72	75.21	4.75
Ether Extract	4.89	3.34	3.36	3.12	37.32
Crude Protein	20.51	20.38	18.91	20.62	20.00
Ash	1.07	1.03	1.01	1.04	13.45

[1]SM: control with soybean meal; [2]SC: formulated with soybean cake; [3]SUC: formulated with sunflower cake; [4]PC: formulated with peanut cake. CV = Coefficient of variation

Cholesterol values were not affected by the inclusion of by-products from the processing of oil seeds, showing values of 38.22 mg 100^{-1} g of meat (Table 6). The values obtained for the meat cholesterol are relatively low (< 90 mg 100^{-1} g) (MADRUGA et al., 2008), which can be important for the health of consumers .

The diets containing by-products from the processing of oil seeds did not change the fatty acids profile found in the meat (Table 6). Ten saturated, six monounsaturated and three polyunsaturated acids were identified. Oleic acid (C18:1) was predominant in all treatments containing by-products from oil seeds. A high concentration of oleic acid in the composition of the intramuscular fat of ruminants has been reported in the literature (MADRUGA et al., 2006).

Table 6. Cholesterol and composition of fatty acids of *Longissimus lumborum* muscle of lambs according to the experimental diets.

	Diets				
Components (% DM)	SM[1]	SC[2]	SUC[3]	PC[4]	CV(%)
Cholesterol (mg 100^{-1} g of meat)	37.70	34.45	40.92	39.81	13.29
C10:0 (Capric)	0.17	0.15	0.16	0.14	17.32
C12:0 (Lauric)	0.08	0.07	0.10	0.08	20.13
C14:0 (Myristic)	2.48	2.23	2.53	2.15	15.74
C14:1 C9 (Myristoleic)	0.13	0.13	0.12	0.11	43.88
C15:0 (Pentadecanoic)	0.48	0.52	0.52	0.44	36.98
C16:0 (Palmitic)	22.47	21.70	23.20	22.53	8.02
C16:1 C9 (Palmitoleic)	2.42	2.26	2.31	2.29	17.41
C17:0 (Margaric)	1.53	1.45	1.09	1.19	27.79
C17:1 (Heptadecanoic)	1.14	1.12	0.80	0.84	39.25
C18:0 (Stearic)	14.33	15.37	16.98	16.79	16.85
C18:1 C9 (Oleic)	42.24	43.05	41.93	42.46	5.30
C18:2 C9 C12 (Linoleic 6)	2.41	2.75	3.61	3.04	26.83
C18:2 C9 T11 (CLA)	0.63	0.59	0.55	0.54	32.70
C18:3 n3 (linolenic)	0.13	0.13	0.12	0.11	25.69
Saturated	43.35	43.12	45.66	44.38	6.49

Monounsaturated	47.69	48.18	46.07	46.63	5.87
Polyunsaturated	3.31	3.61	4.39	3.77	22.92
Unsaturated/Saturated Ratio	1.19	1.21	1.09	1.14	11.70
Monounsaturated/Saturated Ratio	1.12	1.12	1.01	1.06	11.74
Polyunsaturated/Saturated Ratio	0.08	0.08	0.09	0.08	31.06

[1]SM: control with soybean meal; [2]SC: formulated with soybean cake; [3]SUC: formulated with sunflower cake; [4]PC: formulated with peanut cake. CV = Coefficient of variation

The fatty acid content in the meat followed the same proportional order reported by Grande et al. (2009). Oleic acid was the main one, followed in decreasing order by palmitic (C16:0) and stearic (C18:0) acids.

Two other fatty acids, palmitic (21.70 to 23.20%) and stearic (14.33 to 16.98%) also stood out. According to Madruga et al. (2006), these acids are responsible for approximately 90% of the total fatty acids of ruminant meat. The myristic acid (C14:0) and palmitic acid (C16:0) are the fatty acids that deserve the most attention for being considered as hypercholesterolemic (WOOD et al., 2004), which makes the reduction in the content of these fatty acids interesting in beef. Similar values for fatty acids C14:0 (2.52 %), C16:0 (23.46 %) and C18:0 (16.62 %) were reported by Madruga et al. (2006).

Although saturated fat in beef may contribute to the elevation of circulating cholesterol content in humans, fats rich in stearic acid did not show these characteristics. C18:0 is considered to be neutral in the control of plasma cholesterol levels (SCOLLAN et al., 2006).

Once the plasma concentration of cholesterol is influenced by the composition of dietary fatty acids and knowing that oleic fatty acid (C18:1) reduces blood cholesterol, while palmitic acid (C16:0) increases it and that stearic acid (C18:0) has no influence on it, it is important to stress the behavior of these three acids on lamb meat (RHEE, 1992; FIORENTINI et al., 2012).

The concentration of oleic acid (C18:1 C9) had an average value of 32.48 %. This value is slightly greater than found by Madruga et al. (2008) and Enser et al. (1998), 39.44 % and 32.50 %, respectively. The increase in the concentration of oleic acid is highly desirable because this fatty acid has hypocholesterolemic properties (MIR et al., 2003).

Linolenic is an essential fatty acid, as it is the precursor for the synthesis of many PUFA (ODA et al., 2004). These authors highlighted that although most PUFA are not essential, they have an important role in the reduction of blood cholesterol. These results were confirmed by other authors who described a low occurrence of heart disease despite the high consumption of fats in Mediterranean countries where there is a wide use of olive oil and similar products that provide substantial absorption of MUFA, mainly oleic acid.

The inclusion of the by-products had no effect on the concentration of C18:2 C9 t11 (conjugated linoleic acid – CLA). De La Torre et al. (2006) reported that the deposition rate of CLA does not depend on the final quality of body fat of animals, but it is favored by the supply of unsaturated fatty acids in the feeding of animals, even under conditions of lower fat deposition rate, usually observed in younger animals like those used in the present study.

Inclusion of by-products from the processing of oil seeds had no effects on the concentration of saturated (SFA), unsaturated (UFA) and monounsaturated (MUFA) acids or on the unsaturated:saturated (UFA:SFA), monounsaturated:saturated (MSFA:SFA) and polyunsaturated:saturated (PUFA:SFA) acid ratios. These effects are directly related to the fat present in beef, which has an elevated concentration of saturated fatty acids (SFA) and a lower ratio of polyunsaturated to saturated fats when compared to the fat of monogastric animals, that difference is mainly due to the biohydrogenation process that occurs in the rumen by the action of different microorganisms (FRENCH et al., 2000).

Trans-fatty acids are unsaturated and, contrary to cis-UFA, possess double-bonded hydrogen that is available in a transversal form and are the results of ruminal biohydrogenation or industrial processes. Trans-fatty acids are related to harmful effects on human health. Sanhueza et al. (2002) related the effects of trans-fatty acids to the blood lipids, inhibitory action of liver enzymes, modification of cellular membrane fluidity and atherogenic potential. However, long chain PUFA participate in several beneficial metabolic processes for human health (VARELA et al., 2004) and meat fat from ruminants are natural sources of several of these fatty acids.

The total content of PUFA and the ratio of PUFA to SFA were greater in animals fed soybeans than that of animals fed protected fat. An increase in the PUFA: SFA ratio in the human diet is considered a priority for reducing plasma cholesterol (PONNAMPALAM et al., 2001). Silva et al. (2002) reported an average ratio of 0.20, which was a value greater than verified in this study. The PUFA: SFA ratio was lower than recommended by the Department of Health of the United Kingdom, which recommends a value of approximately 0.4, characterizing a healthier diet. Therefore, Jakobsen (1999) suggests a reduction in the ingestion of fats rich in cholesterol and SFA and an increase in the intake of MUFA and PUFA to reduce the risk of obesity, cancer and cardiovascular diseases.

Higher values of oleic acid are desirable for hypocholesterolemic activity, with the advantage of not reducing high-density lipoprotein (HDL) cholesterol (good cholesterol), protecting thus against coronary diseases.

Conclusion

The use of by-products from the processing of soybean, sunflower and peanut has promoted similar carcass and meat characteristics, in this way their use can be recommended as eventual sources of protein for feedlot lambs without any impairment to the carcass quality and fatty acids profile.

Diets containing these by-products presented satisfactory deposition of fatty acids and greater presence of essential fatty acids are associated with better composition and meat quality.

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