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ARTICLE

Performance and carcass characteristics of cattle fed lipid sources in the diet

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Abstract: The aim of this study was to determine the effect of the inclusion of different lipid sources [whole cottonseed (CS) and protected fat in diets containing sugarcane, corn, citrus pulp, CS meal, and urea] on animal performance, hot carcass dressing (HCD), ribeye area (RA), fat thickness (FT), and postmortem pH of the meat of Nellore cattle during finishing. The treatments evaluated were feed with 2.50% CS (control diet, T1 treatment); feed with 11.50% CS (high CS, T2 treatment); and feed with 3.13% CS added of protected lipid (PL) (T3 treatment), all on a DM basis. The forage:concentrate ratio of the diet was 50:50. Thirty-nine intact steers with average initial body weight of 494 kg and 36 months old were confined for 63 d. The addition of lipid sources tested in this study did not affect dry matter intake, crude protein intake, neutral detergent fiber intake, final live weight, average daily weight gain, HCD, RA, FT, and meat pH. It was concluded that the addition of PLs in the diet did not affect weight gain and carcass characteristics.

Key words: fat, protected fat, ribeye area, production efficiency, weight gain, whole cottonseed.

Résumé : Le but de cette étude était de déterminer l'effet de l'ajout de différentes sources de lipides (graine entière de coton et gras protégés dans les diètes contenant la canne à sucre, le maïs, la pulpe d'agrumes, le tourteau de graine de coton et l'urée) sur la performance animale, l'habillage des carcasses à chaud (HCD — « hot carcass dressing »), l'aire du faux-filet (RA — « ribeye area »), l'épaisseur du gras (FT — « fat thickness »), ainsi que le pH postmortem de la viande des bovins Nellore pendant la finition. Les traitements évalués étaient : nourriture avec 2,50 % de graines de coton (diète témoin, appelée traitement T1); nourriture avec 11,50 % de graines de coton (forte teneur en graines de coton, appelée traitement T2); et nourriture avec 3,13 % de graines de coton ajoutées des lipides protégés (appelée traitement T3), le tout basé sur les matières sèches. Le ratio de fourrage à concentré était de 50:50. Trente-neuf bouvillons intacts de poids corporel initial moyen de 494 kg et âgés de 36 mois ont été confinés pendant 63 jours. L'ajout des sources de lipides à l'essai lors de cette étude n'a pas eu d'effet sur l'ingestion des matières sèches (DMI — « dry matter intake »), l'ingestion de protéines brutes (CPI — « crude protein intake »), l'ingestion des fibres aux détergent neutre, le poids corporel final vif, le gain de poids moyen quotidien, le HCD,

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Abbreviations: ADFom-ADF, acid detergent fiber expressed exclusive of residual ash; **aNDFom-NDF**, neutral detergent fiber assayed with a heat stable amylase and expressed exclusive of residual ash; **aNDFom-NDFI**, NDF intake; **CD**, control diet; **CS**, cottonseed; **CSFA**, calcium salts of fatty acid; **CP**, crude protein; **CPI**, crude protein intake; **DE**, digestible energy; **DM**, dry matter; **DMI**, dry matter intake; **DWG**, daily weight gain; **EE**, ether extract; **FLW**, final live weight; **FT**, fat thickness; **HCD**, hot carcass dressing; **HCW**, hot carcass weight; **ILW**, initial live weight; **LIG(sa)**, lignin determined by solubilization of cellulose with sulfuric acid; **ME**, metabolizable energy; **MM**, mineral matter; **NFCs**, nonfiber carbohydrates; **PL**, protected lipid; **RA**, ribeye area; **TDNs**, total digestible nutrients.

Conflict of interest: The authors declare that they have no conflict of interest related to this study.

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la RA, la FT, et le pH de la viande. Il a été conclu que l'ajout des lipides protégés à la diète n'a pas d'effet sur le gain de poids et les caractéristiques de la carcasse. [Traduit par la Rédaction]

Mots-clés : gras, gras protégé, aire du faux-filet, efficacité de production, gain de poids, graine entière de coton.

Introduction

The current low profitability of the Brazilian beef industry stimulates the search for technologies that may increase herd productivity. Feed cost is an important factor impacting the successful confinement of beef cattle (Maxwell et al. 2015). According to Leme et al. (2003), feed represents about 85% of the production costs, with concentrate cost as the main limiting factor in this system.

Nowadays, except for some market niches, carcasses should have a greater proportion of muscle and minimum amount of fat. Fat content should be just enough to prevent dehydration and darkening under refrigeration and to ensure meat juiciness and taste (Luchiari Filho 2000; Agastin et al. 2013). Adequate carcass yield and fat thickness (FT) should be achieved taking economic aspects into consideration.

The use of alternative products and by-products from agroindustrial activities may be an option to feed beef cattle in an attempt to reduce costs. The use of fatty by-products may be an alternative to decrease the use of starch-rich feeds without compromising the energy levels of the diet. Cottonseed (CS) is one of the ingredients that have been widely used in ruminant feeding to achieve this aim (Cranston et al. 2006; Costa et al. 2013; Lima et al. 2015*a*). However, it is important to consider that excess dietary lipids may cause negative impacts on the digestion of fiber in the rumen and may influence animal performance (Palmquist and Conrad 1980; Jenkins 1993). The use of calcium together with fat in the diet [protected lipid (PL)] helps prevent the negative effects of dietary fiber on digestion in diets containing more than 40% forage (Rogério et al. 2003; Costa et al. 2011). Therefore, in specific feeding conditions, the use of PLs is an adequate alternative.

The objective of this study was to investigate if access to lipid sources such as CS or CS added of PL may improve performance and carcass characteristics in beef cattle.

Materials and Methods

All experimental procedures followed the guidelines of the Canadian Council on Animal Care (CCAC 2009).

Experimental site

The study was carried out in a beef cattle farm located at 22°04′00″S, 47°09′03″W, average altitude of 615 m (Brazil). The region is characterized by a hot, humid season from October to March followed by a cold, dry season from May to September. The climate of the region is classified as Cwa by the Köppen classification (mesothermal, with hot and humid summers and dry winters).

Animal management, feeding, and treatment

A group of 39 intact male Nellore animals raised in *Brachiaria humidicola* pastures were used in the study. Mean age of the animals was 36 mo, and initial mean live weight was 494.05 ± 10.05 kg [standard error (SE)]. Animals were identified and dewormed before the beginning of the trial.

Animals were then randomly assigned to one of the three treatments, on a dry matter (DM) basis: feed with 2.50% CS (control diet, called T1 treatment), feed with 11.50% CS (high CS, called T2 treatment), and feed with 3.13% CS with the addition of 1.77% PL (CS + PL, called T3 treatment). Animals were confined for 63 d. Diets were formulated according to the Cornell Net Carbohydrate and Protein System software (CNCPS 4.0; Cornell University 2000) for uncastrated finishing cattle to provide weight gains of 1.4 kg animal^{-1} d^{-1}. Forage:concentrate ratio was 50:50. Sugarcane was used as forage, and concentrate was made up of urea, cracked corn kernels, citrus pulp, cotton meal, CS, and (or) PL. The PL used in this study was made from commercial soybean oil, which undergoes saponification with calcium salts for protection of the long-chain fatty acids. Laboratory analysis of this product showed the following nutritional composition: 95.5% DM, 85.2% ether extract (EE), and 14.8% mineral matter (MM). Animals were fed manually every day at 0800 and 1600 in a whole diet system with about 5% leftovers, which were weighed in the morning for diet adjustment. Nutritional composition of the diets is shown in Table 1.

During the experimental period, animals were weighed every 21 d, always after a 14-h solid food fasting, to assess mean daily weight gain (DWG), calculated as the difference between the latest and actual live weights divided by the number of days in the respective period.

Samples of the experimental diets, sugarcane, and concentrate were collected every 7 d, placed in plastic bags, and stored in a freezer (–4 °C) to be analyzed later. After thawing, composite samples were obtained for a 21-d period. Samples of feed and forage were weighed and oven dried at 60 °C for 72 h. Then, samples were processed in a Wiley® knife mill to pass through 1-mm screen sieves and stored in plastic bags. Samples were analyzed for DM, crude protein (CP), and MM according to the Association of Official Analytical Chemists (AOAC) (1990), EE (Thiex et al. 2003), neutral detergent fiber assayed with heat stable amylase and expressed exclusive of residual ash (aNDFom-NDF), acid detergent fiber expressed exclusive of residual ash (ADFom-ADF)

Table 1. Percentage composition of the diets on a DM basis.

	Treatment		
Ingredients (%)	T1	T2	T3
Sugarcane	50.00	50.00	50.00
Cracked corn	14.64	13.07	13.12
Citrus pulp	21.61	17.81	20.61
Cottonseed	2.50	11.50	3.13
Cottonseed meal	9.30	5.78	9.42
Urea	0.83	0.83	0.83
Protected fat	—	—	1.77
Mineral mix[a]	0.83	0.83	0.83
Potassium chloride	0.28	0.17	0.28
Ionophores	0.01	0.01	0.01

Note: Percentage composition of the diets: T1 = treatment with 2.50% CS, T2 = treatment with 11.50% CS, and T3 = treatment with 3.13% CS added of 1.77% PL.

[a]Composition per kilogram: P = 60 g; Ca = 180 g; Mg = 5 g; S = 17 g; Na = 135 g; Cu = 650 mg; Mn = 500 mg; Zn = 2400 mg; I = 48 mg; Co = 38 mg; Se = 12 mg.

(Van Soest et al. 1991), and acid method of fiber analysis [LIG(sa); AOAC 1990; Gomes et al. 2011] after sequential extractions with neutral detergent followed by acid detergent (Van Soest et al. 1991). In the aNDFom-NDF analyses, thermostable α-amylase was used without sodium sulfite (Mertens 2002), using an Ankom® fiber extractor, according to Valente et al. (2015). Nonfiber carbohydrates (NFCs) in the ingredients of the diets were determined by the following equation: NFC = 100 − (%aNDFom − NDF + %CP + %EE + %MM), according to Sniffen et al. (1992). Due to the presence of urea in the diets, NFC was calculated as indicated by Hall (2000): NFC = 100 − [(%CP − %CP from urea + %urea) + %aNDFom − NDF + %EE + %MM]. Estimated metabolizable energy (ME; in Mcal kg^{-1} of DM) was determined according to the National Research Council (NRC) (1996) recommendations, considering that 1 kg of total digestible nutrients (TDNs) contains 4.409 Mcal of digestible energy (DE), with the factor 0.82 used in the conversion from ED to EM. Results of these analyses carried out in the software CQBAL 3.0 (Valdares Filho et al. 2012) are shown in Tables 2 and 3.

After 63 d of the study, animals were weighed for the last time after a 14-h solid food fasting. Mean final live weight (FLW) was 577.01 ± 11.34 kg. Soon after being weighed, animals were transported to a slaughterhouse, in solid food fasting until the moment they were slaughtered. After slaughter, carcasses were identified and divided into two halves that were kept in a cold chamber for 24 h at 2 °C.

Chemical analysis of the meat

The pH of the meat 24 h after slaughter of the animals was determined in the *longissimus thoracis* muscle, near the 12th and 13th ribs, using a pH meter. After that, part of *longissimus thoracis* was removed from each left half carcass. These samples yielded 2.5-cm thick steaks that were identified, vacuum packed in plastic bags, and then frozen in a freezer at −18 °C. Before the analyses, samples of the *longissimus thoracis* were thawed to 4 °C in a refrigerator for 24 h and then removed from the plastic bags to be analyzed.

Ribeye area (RA) measurement in the *longissimus thoracis* was carried out by drawing on tracing paper followed by observation in a scanner (model MDD 1812 — DIGICOM). Images were analyzed in a computer provided with SPLAN software. Evaluation of FT was carried out by means of a digital pachymeter (Digimess®) at the top area of the *longissimus thoracis* muscle.

Hot carcass dressing

Hot carcass dressing (HCD) was determined by means of the ratio between hot carcass weight (HCW) (immediately after carcass trimming) and FLW (Müller 1980), obtained the last time that the animals were weighed at the farm, after a 14-h solid food fasting.

Statistical procedures and model evaluation

A completely random design with three treatments and 13 repetitions was used, according to the $Y_{ij} = \mu + T_i + e_{ij}$ model, where Y_{ij} is the value observed in the jth experimental unit (animal) that received the ith treatment; μ is the overall mean; T_i is the fixed effect of the ith treatment; and e_{ij} is the experimental error related to the experimental unit. Data on initial weight, slaughter weight, live weight gain, HCD, RA, and FT were analyzed by means of the GLM (generalized linear models) of the SAS/STAT 9.0 software (SAS Institute Inc. 2002), and means were compared using Tukey's test at a 5% significance level.

Results

No differences ($P > 0.05$) were found for the three treatments for dry matter intake (DMI), crude protein intake (CPI), or NDF intake (aNDFom-NDFI), shown in Table 4. Mean DMI was 11.55 kg d^{-1}, while CP intake was 1.24 kg d^{-1}. Mean aNDFom-NDFI was 5.20 kg d^{-1}.

Table 5 shows mean FLW and mean DWG of Nellore cattle according to the lipid source in their diets. It may be noted that there were no differences ($P > 0.05$) among the treatments, mean FLW was 577.01 kg, and DWG was 1.32 kg d^{-1}.

There were no differences ($P > 0.05$) among treatments for HCW and HCD of Nellore cattle as a function of the lipid sources in the diet (Table 6), with mean values of 293.45 kg for HCW and 49.94% to HCD.

Results related to RA are shown in Table 6. It may be observed that there were no differences ($P > 0.05$) among the treatments and that the mean value was 82.95 cm^2. However, T1 treatment showed higher results: 86.31 cm^2 vs. 80.52 cm^2 observed in T3 treatment.

Table 2. Mean chemical composition of ingredients used in the experimental diets as percentage dry matter (DM) of crude protein (CP), ether extract (EE), nonfiber carbohydrates (NFCs), neutral detergent fiber (aNDFom-NDF), acid detergent fiber (ADFom-ADF), lignin (LIG), and mineral matter (MM).

		% Dry matter						
Ingredients	DM (%)	CP	EE	NFC[a]	aNDFom-NDF	ADFom-ADF	LIG	MM
Sugarcane	30.27	2.82	2.93	29.06	62.43	39.56	6.85	2.76
Cracked corn	87.02	8.73	4.46	71.46	14.42	5.32	2.75	0.93
Citrus pulp	87.94	5.87	3.5	64.78	21.38	16.75	7.52	4.47
Cottonseed	91	19.67	20.83	1.36	54.65	45.44	17.03	3.49
Cottonseed meal	87.24	46.08	1.94	0.12	45.66	28.32	9.91	6.2
Protected lipid	95.47	—	85.21	—	—	—	—	14.79
Urea	99.51	287.84	—	—	—	—	—	—

Note: Mean chemical composition of ingredients for treatments.
[a]NFC according to Sniffen et al. (1992).

Table 3. Mean chemical composition of experimental diets for dry matter (DM), crude protein (CP), ether extract (EE), nonfiber carbohydrates (NFCs), neutral detergent fiber (aNDFom-NDF), mineral matter (MM), total digestibility nutrient (TDN), and metabolizable energy (ME) used in different treatments.[a]

	Treatment		
Item	T1	T2	T3
DM	58.09	58.50	58.26
CP	11.11	10.90	11.11
EE	3.57	5.18	5.11
NFC[b]	38.61	35.03	36.88
aNDFom-NDF	43.56	45.83	43.52
MM	3.15	3.06	3.38
TDN[c]	67.55	68.16	68.99
ME[d]	2.44	2.46	2.49

Note: There is no significant difference between means within each column at the $P < 0.05$ level.
[a]Data are means of 13 observations per treatment; T1 = treatment with 2.50% CS, T2 = treatment with 11.50% CS, and T3 = treatment with 3.13% CS added of 1.77% PL.
[b]NFC according to Hall (2000).
[c]Estimated in the feed composition according to the Valdares Filho et al. (2012) and the NRC (2001).
[d]ME, estimated metabolizable energy, in Mcal kg^{-1} of DM, according to the NRC (1996).

There were no differences ($P > 0.05$) between treatments in relation to FT, and mean value was 2.61 mm (Table 6). T2 treatment showed mean value of 2.98 mm, which was the highest value found.

No differences in meat pH 24 h after slaughter were observed in Nellore cattle fed different sources of fat (Table 6), and mean value for this variable was 5.59.

Discussion

The addition of fat to the diet did not alter the intake of DM, CP, and neutral detergent fiber compared with the control diet. Similar results were obtained by Rosa et al. (2013) in a recent study with young Nellore bulls fed different sources of fat, protected or not from rumen degradation. Diets were formulated with the same amount of protein and with a forage:concentrate ratio of 40:60, with sugarcane as the only roughage. Formulation of diet in this experiment was very similar, with a forage:concentrate ratio of 50:50, with sugarcane as the only source of forage. Normally, there is a reduction in DMI in ruminants fed lipids (Jenkins 1993). However, other authors, e.g., Cranston et al. (2006), reported increased DMI in cattle fed diets containing CS compared with those fed the CD diet, and the response was possibly a function of NDF and energy concentrations of the diets, which are generally negatively correlated (diets with greater fiber concentrations tend to be less energetically dense).

The absence of differences ($P > 0.05$) between the treatments in relation to FLW and DWG is due to the level of EE in the diet in this study, and this fat concentration did not compromise animal performance. However, Rosa et al. (2013) in a study in Brazil with young Nellore bulls in a feedlot concluded that the inclusion of vegetable oils, protected or not from rumen degradation, improves performance and carcass characteristics, regardless of the type of fat. DWG in this study was within the expected range. The diet was planned for DWG of 1.4 kg, and Nellore steers showed a mean gain of 1.32 kg, with T1 showing lower DWG, with mean of 1.24 kg. According to Lima et al. (2015*b*), more studies are necessary on the nutrition, performance, and carcass characteristics of ruminants. The main problem found in feedlots is related to metabolic disorders caused by excess starch fermentation in the rumen. The addition of lipid can be an alternative to decreasing the inclusion of starch, maintaining the same energy level of the diet (Palmquist and Conrad 1980). T2 treatment had the highest EE value (5.18%) although, according to the extensive review of Jenkins (1993), this fat content is not enough to affect the development of rumen microorganisms. In studies with the same variables, Aferri et al. (2005), with

Table 4. Mean, standard error (SE), and probability (*P* value) for dry matter intake (DMI), crude protein intake (CPI), and neutral detergent fiber intake (aNDFom-NDFI) for the different treatments.[a]

	Treatment					
Item	T1	T2	T3	Mean	SE	*P* value
DMI (kg d^{-1})	11.51	11.44	11.72	11.55	0.25	0.72
CPI (kg d^{-1})	1.24	1.21	1.26	1.24	0.02	0.48
aNDFom-NDF (kg d^{-1})	5.10	5.32	5.19	5.20	0.11	0.46

Note: There is no significant difference between means within each column at the $P < 0.05$ level.

[a]Data are means of 13 observations per treatment; T1 = treatment with 2.50% CS, T2 = treatment with 11.50% CS, and T3 = treatment with 3.13% CS added of 1.77% PL.

Table 5. Mean, standard error (SE), and probability (*P* value) for the variables initial and final mean live weights (ILW and FLW) and mean daily weight gain (DWG) of the different treatments.[a]

	Treatment					
Item	T1	T2	T3	Mean	SE	*P* value
ILW (kg)	486.0	498.62	497.54	494.05	10.05	0.62
FLW (kg)	564.12	581.81	585.12	577.01	11.34	0.38
DWG (kg d^{-1})	1.24	1.32	1.39	1.32	0.07	0.31

Note: There is no significant difference between means within each column at the $P < 0.05$ level.

[a]Data are means of 13 observations per treatment; T1 = treatment with 2.50% CS, T2 = treatment with 11.50% CS, and T3 = treatment with 3.13% CS added of 1.77% PL.

Table 6. Mean, standard error (SE), and probability (*P* value) for the variables hot carcass weight (HCW), hot carcass dressing (HCD), ribeye area (RA), fat thickness (FT), and pH 24 h after slaughter of the different treatments.[a]

	Treatment					
Characteristics	T1	T2	T3	Mean	SE	*P* value
HCW (kg)	287.58	298.25	294.51	293.45	7.12	0.57
HCD (%)	50.03	50.42	49.37	49.94	0.41	0.20
RA (cm^2)	86.31	80.52	81.94	82.95	4.34	0.61
FT (mm)	2.41	2.98	2.41	2.61	0.37	0.47
pH 24 h	5.66	5.54	5.57	5.59	0.06	0.34

Note: There is no significant difference between means within each column at the $P < 0.05$ level.

[a]Data are means of 13 observations per treatment; T1 = treatment with 2.50% CS, T2 = treatment with 11.50% CS, and T3 = treatment with 3.13% CS added of 1.77% PL.

diets containing higher levels of calcium salts of fatty acid (CSFA; 5% of diet or up to 21% CS), did not observe differences when compared with the diet without the additional lipid source [control diet (CD)]. The level of EE used in this experiment had no effect on the performance of steers in the feedlot period. Other authors, e.g., Silva et al. (2007), did not observe any differences between diets when they studied weight gain in Nellore cattle fed 4% CSFA or no lipid source. The authors stated that the use of CSFA as an option to increase energy density of the diet for confined cattle should be better analyzed due to the high cost of the product. Pesce (2008),

however, observed greater DWG in Nellore steers that received 10% CS in DM of the diet compared with those fed without the fat source (CD). Andrade (2010), who tested the inclusion of PL in the diets of young Angus × Nellore feedlot bulls, did not observe differences between the diets when HCD was determined.

According to Silva et al. (2002), Nellore cattle, mainly intact males, have always been considered as showing carcasses of inferior quality due to the deficient fat cover. With the absence of fat during cooling of the carcass, the outside of the muscles can become dark (negatively affecting the visual aspect), and a cell shortening may occur, affecting the commercial value. Carcass yield is important to complement the evaluation of animal performance. The most important objective in attempts to change carcass composition is greater concentration of muscle, adequate fat levels, and minimum levels of bones (Luchiari Filho 2000). In Brazil, HCD and FLW are of great economic importance for the meat industry. However, RA features may be used together with HCD and FLW to determine the price paid to the farmer, because they show a positive correlation with the yield in cuts of greater value (Gomide et al. 2006).

Similar to the findings of the present study, Aferri et al. (2005) evaluated RA and did not observe differences between diets containing CSFA or CS as the lipid source. In their study, these authors observed RAs of 71.5 and 66.9 cm^2, respectively. These authors used young castrated animals, which may have contributed to the lower RA compared with the present study. RA is one important carcass characteristic, because it is related to muscle mass and is used as an indicator of the yield of cuts of high commercial value, presenting a positive correlation with the edible portion of the carcass (Luchiari Filho 2000). In the present study, RA results when PL was added to the diet (Table 6) were close to those reported by Andrade (2010), 85.87 cm^2 when this same fat source was used. Similarly, in the present study, no differences were observed between the diets with and without PL.

Mean FT in the present study (Table 6) was a little lower than the minimum required by the meat industry (3 mm) (Mezzomo et al. 2015). When animals do not reach this minimum thickness, the meat industry may devalue the carcass and pay less money to the farmer, a fact that was observed in this study. However, T2 treatment showed the greatest FT value, equal to 2.98. As in the present study, Aferri et al. (2005) did not observe differences in FT when the sources of lipids (CS or PL) included in the diet were considered. Similarly, in a study of the effect of PL in the diet of young Angus × Nellore animals, Andrade (2010) did not observe differences for this variable in diets with or without sources of lipids.

Final pH values were not different among treatments (Table 6). The average value was 5.59, without differences between treatments. Final pH values were in the normal range (5.4–5.8) for beef cattle (Mach et al. 2008). After the animal was slaughtered, blood circulation ceases and anaerobic biochemical reactions start, which produce lactic acid, responsible for the fall of pH. This acidification process is dependent on the amount of glycogen available in the muscle, depends on the diet that the animal received, and the stress level of the animal before slaughter (Soria and Corva 2004). T1 treatment showed a pH of 5.66 and was the highest value found, though without any apparent explication. Several stress factors have been reported as responsible for glycogen depletion: duration of transport and handling from farm to slaughterhouse, temperament, buffering capacity of muscle, climatic factors, live weight, gender, and others (Immonen and Puolanne 2000; Gardner and Thompson 2003; Bee et al. 2006; King et al. 2006). According to Mach et al. (2008), only meat with a pH above 6.0 shows a quality problem, is undesirable for human consumption, and leads to dark, firm, and dry carcasses. In Brazil, meat plants export only meat with pH values lower than 5.8, determined directly on the *longissimus thoracis* muscle 24 h after slaughter (Fernandes et al. 2008). Aferri et al. (2005), who studied the use of additional fat in the diets of confined crossbred beef steers, found similar mean pH value of 5.56 after 24 h. The final pH values suggest that there was no increased stress before slaughter, because acidification of the muscle occurred as expected, and that the addition of fat sources in diet evaluated did not affect the final pH. Oliveira et al. (2011), working in Brazil with Nellore feedlot cattle, also did not observe differences in pH values among treatments in evaluation of diets without or with additional lipids.

The absence of differences ($P > 0.05$) in the variables HCW and HCD among the treatments of the present study was also found by Aferri et al. (2005), who fed cattle diets containing CS, CSFA, or no source of fat. The results of the present study, as well as those of other authors, indicate that fat sources tested do not negatively affect HCW and HCD.

Conclusion

In the present study, the inclusion of PL in the diet did not interfere with weight gain and the characteristics of the carcass in finishing cattle, and the same finding was observed in the animals that were fed only CS as their lipid source.

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