Soybean oil and linseed grains on performance and carcass characteristics of crossbred bulls finished in feedlot

Óleo de soja e grãos de linhaça sobre o desempenho e características de carcaça de bovinos cruzados terminados em confinamento

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Abstract

This experiment was carried out to study soybean oil and linseed as feeding alternatives to improve the animal performance and the carcass characteristics of crossbred bulls finished in feedlot for 105 days. There were used 21 bulls with 18 months old randomized in three treatments (n=7): control (CON) which offered concentrate based on corn; soybean oil + linseed grains (LS1); soybean oil + linseed grains (LS2) that had an experimental time divided in two periods: 60 days with soybean oil and the remaining 45 days with soybean oil + linseed grains. No differences (P>0.05) were observed among treatments on the initial body weight (343 kg), final body weight (501 kg), average daily gain (1.50 kg), hot carcass weight (262 kg), carcass dressing (52.4%), fat thickness (5.40 mm), *Longissimus* area (88.0 cm^2), *Longissimus* area/100 kg (33.7 cm^2) dry matter conversion (8.00 kg DM/1 kg of body weight), dry matter intake (11.8 kg), dry matter intake/live body weight (2.80%), crude protein intake (1.20 kg), gross energy intake (52.9 Mcal/day), acid detergent fiber intake (2.30 kg), acid detergent fiber intake/100 kg of live body weight (0.50%), neutral detergent fiber intake (2.38 kg) and neutral detergent fiber intake/100 kg of live body weight (0.90%). Therefore, soybean oil and linseed can be used to replace corn in beef cattle diets without reducing the animal performance and the carcass characteristics.
Key words: Average daily gain, beef cattle, dry matter conversion, energy intake

Resumo

Este experimento foi realizado para estudar o óleo de soja e grãos de linhaça como alimentos alternativos na alimentação animal para melhorar o desempenho e as características de carcaça de animais inteiros cruzados e terminados em confinamento por 105 dias. Foram utilizados 21 animais inteiros com 18 meses de idade distribuídos em três tratamentos (n=7): controle (CON), onde foi oferecido concentrado a base de milho; óleo de soja + grãos de linhaça (LS1) e óleo de soja + grãos de linhaça (LS2), onde o período experimental foi dividido em duas etapas: 60 dias com óleo de soja e 45 dias com óleo de soja e grãos de linhaça. Não houve diferença (P>0,05) entre os tratamentos para peso inicial (343 kg), peso final (501 kg), ganho médio diário (1,50 kg), peso da carcaça quente (262 kg), rendimento de carcaça (52,4%), gordura de cobertura (5,40 mm), área de olho de lombo do *Longissimus* (88,0 cm^2), área de olho de lombo do *Longissimus*/100 kg (33,7cm^2), conversão de matéria seca (MS) (8,00 kg MS/1 kg peso vivo), ingestão de matéria seca (11,8 kg), ingestão de matéria seca/peso vivo (2,80%), ingestão de proteína bruta (1,20 kg), ingestão de energia (52,9 Mcal/dia), ingestão de fibra em detergente ácido/100

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Recebido para publicação 15/01/09 Aprovado em 18/11/09

kg de peso vivo (0,50%), ingestão de fibra em detergente neutro (2,38 kg) e ingestão de fibra em detergente neutro/100 kg de peso vivo (0,90%). Dessa forma, óleo de soja e grãos de linhaça podem ser utilizados para substituir o milho em dietas para bovinos inteiros sem que haja alteração no desempenho animal e nas características de carcaça.
Palavras-chave: Bovinos de corte, conversão da matéria seca, ganho médio diário, ingestão de energia**.**

Introduction

The beef industry has expanding the meat market by producing some competitive products based on differential aspects of quality. In this way, the maximum performance has been required for achieving such purpose and animals have been slaughtered earlier for obtaining a tender and low fat meat that is very much healthy to customers (MACEDO et al., 2008; PRADO et al., 2008a; b; c; d; DUCATTI et al., 2009; PRADO et al., 2009a; b; c). In this away, highly caloric feed sources have also appeared as an alternative to the traditional components (MULLER et al., 2008).

Meat is considered one of the factors that may lead to the development of human cardiovascular diseases, obesity, hypertension and cancer, especially due to the presence of saturated fat and cholesterol. Low presence of fat contents (less than 3% relative to muscle) (MOREIRA et al., 2003; PADRE et al., 2006, 2007; ROTTA et al., 2009a; b) and low cholesterol contents (less than 50 mg 100 g^{-1} in the muscle) have been observed in meat chemical analyses, ranging from one-third to one-half of the daily recommended cholesterol intake (GREGHI et al., 2003; PADRE et al., 2006, 2007).

Feedlot has been a cost effective alternative for raising beef cattle in those regions where either the grassland price or dietary components are inflating the operating costs. Consequently, both conditions require the use of intensive systems to produce meat of high quality (KAZAMA et al., 2008; PRADO et al., 2008a; b; MAGGIONI et al., 2009a; b). Today, the use of cereal grains like corn have usually been the main source of energy in finishing diets but oils and fats can also be used as alternative components (MOREIRA et al., 2005; MULLER et al., 2008).

However, they are more expensive than carbohydrate sources (corn) or any other agri-industrial by-product, a fact which has compromising, in many cases, their use as energy suppliers for raising beef cattle (MOREIRA et al., 2005).

Nevertheless, these lipid sources have had strong influence in rumen fermentation because they compromise the cellulolytic activity of microorganisms and reduce the animal performance when offered in large quantities. Today, the use of conventional sources of fat on beef cattle diets has still been small (HIGHTSHOE et al., 1991) because some papers (ANDRAE et al., 2000; ENGLE et al., 2000) have described reducing effects on the intake and in the efficiency of fiber digestion although such effects depend on the way fat is offered to the animals. In such way, vegetal oils are strong inhibitors of microorganisms' activity in comparison to animal fat because they are more unsaturated.

The high average gain of 2.00 kg/day were reported by Andrae et al. (2000) who fed 60 crossbred steers with 82.0% of corn + 12.0% of triticale silage, 82.0% of high oil corn + 12.0% of silage, and high-oil corn which were formulated to be iso energetic to the control which had 74.0% of high oil corn + 20.0% of silage. On the other hand, Kazama et al. (2008) reported gain of 1.30 kg/day from crossbred heifers (*Bos taurus* taurus *vs. Bos taurus* indicus) finished in feedlot with diets containing 22.0% of cotton seed hulls, 45.0% soybean hulls, 7.00% cotton seed meal, 23.5% of corn germ meal or rice bran, 0.80% of mineral salt, 0.80% limestone and 1.20% urea.

Moreover, oil seeds are better as the source of fat because their embryos are efficiently surrounded by the tegument which protects ruminal microorganisms (SOUZA et al., 2007). The use of protected fat like linseed has been studied to promote increases of unsaturated fatty acids like omega-3 and omega-6 which add significant benefits to the human health (ARICETTI et al., 2008).

This experiment was carried out to evaluate the effects of soybean oil with linseed grains on the animal performance and carcass characteristics of crossbred bulls finished in feedlot.

Material and Methods

Animals and management

The Committee of Animal Production at State University of Maringá approved this experiment which was carried out at Beef Cattle Section in Iguatemi Research Farm and followed the guiding principles of biomedical research with animals (CIOMS, 1985). Feed samples were analyzed at Laboratory of Feed Analyses and Animal Nutrition at State University of Maringá, Northwestern Paraná, South Brazil.

Twenty one crossbred bulls (½ Nellore x ½ Simmenthal) with average of 18 months old and initial body weight of 343 kg were previously identified and kept separate into 10m^2 pens for 105 days. Each pen was fenced with steel poles and protected by concrete floor. Fifty percent of the area was covered by zinc roof under which were placed troughs with 2 m in length. Water tanks with the volume of 250 liters were set up on the opposite side. The animals were accommodated to the experimental conditions for 10 days when they were wormed and supplemented with ADE vitamin.

Experimental diets

There were used 21 animals randomized in three treatments (n=7): control (CON) which offered concentrate based on corn; soybean oil + linseed grains (LS1); soybean oil + linseed grains (LS2) that had an experimental time divided in two periods: 60 days with soybean oil and the remaining 45 days with soybean oil + linseed grains (Table 1).

Table 1. Composition of the experimental diets (g/kg).

	Treatments		
Ingredients	CON[a]	OIL1[b]	OIL2[c]
Corn silage	566	723	724
Ground corn grain	398	179	179
Linseed	---	47.0	47.0
Soybean oil	---	20.0	20.0
Soybean meal	23.0	18.0	18.0
Limestone	4.00	4.00	4.00
Mineral salts	4.00	4.00	4.00
Urea	4.00	5.00	4.00

[a]Control, [b]Soybean oil + linseed (105d), [c]Soybean oil (60d) + linseed (45 d).

These diets were formulated to be iso-nitrogenous and iso-energetic and followed the recommendations of the NRC (1996) to achieve the body weight gain of 1.30 kg/day. The dietary supplement was stipulated to allow the possibility of 5% of refusal in the trough. The complete diets (roughage + concentrate) were daily offered at 8:00 am and 04:00 pm. The chemical composition of ingredients and experimental diets are presented in (Table 2).

Table 2. Chemical composition of ingredients and experimental diets (g/kg).

	g/kg							
Ingredients	DM[a]	MM[b]	OM[c]	CP[d]	NDF[e]	ADF[f]	GE[g]	EE[h]
Corn silage	335	46.0	954	75.0	457	294	44.4	30.5
Ground corn grains	891	10.4	990	80.0	126	31.1	43.2	37.0
Linseed	935	34.5	966	231	484	348	65.0	404
Soybean oil	998	---	---	---	---	---	97.3	1000
Soybean meal	886	49.1	951	508	150	111	47.1	18.0
Limestone	999	995	4.60	---	---	---	---	---
Mineral salts	987	899	107	---	---	---	---	---
Urea	988	---	---	2736	---	---	---	---
CON[i]	577	38.9	956	99.6	313	181	43.4	32.4
LS1[j]	494	45.2	930	102.	379	237	45.7	69.0
LS2[k]	533	41.7	933	98.9	338	203	44.6	51.1

[a]Dry matter, [b]Mineral matter, [c]Organic matter, [d]Crude protein, [e]Neutral detergent fiber, [f]Acid detergent fiber, [g]Mcal/kg DM, [h]Ether extract, [i]Control, [j]Soybean oil + linseed (105), [k]Soybean oil (60d) + linseed (45 d).

The animals were weighed at trial entry and every 28 day interval before the first feeding. The feed intake was recorded daily by weighing leftovers every morning. Feed diets and leftovers, dry matter, organic matter, crude protein, ether extract, gross energy, neutral detergent fiber and acid detergent fiber were determined according to Silva and Queiroz (2002).

Carcass evaluation

The animals were slaughtered at a commercial slaugther 50 km from the Iguatemi Research Farm following the usual practice of the Brazilian beef industry where the carcasses were weighed, indentified, and chilled at 2ºC for 24 hours. Samples were collected by taking a complete cross section between the 12th and 13th rib and were immediately delivered at the laboratory facilities for evaluating the fat thickness and *Longissimus* area.

A micrometer of high precision was used to determine fat thickness; the final result was an average of three measurements (mm). The *Longissimus* area was accomplished by using vegetal paper where the diameter of the muscle was reproduced and the area (cm^2) was taken by the planimeter method.

Statistical analysis

It was used a complete randomized design with three treatments and seven replicates. The data were analyzed using the SAS Software (SAS, 2000), following the model $Y_{ij} = \mu + t_i + e_{ij}$ in which Y_{ij} = record of the *j* animal submitted to the *i* treatment; μ = general constant; t_i = the effect from the *i* treatment; i = 1, 2, 3; e_{ij} = random error associated to the Y_{ij} record. Significant differences were evaluated by the Tukey test at the level of 5% of probability.

Results and discussion

Animal performance

No difference (P>0.05) among treatments were observed for the following variables: initial body weight (IBW), final body weight (FBW), average daily gains (ADG), dry matter feed conversion (DMC), dry matter intake (DMI), dry matter intake/ live body weight (DMI/LW), crude protein intake (CPI), gross energy intake (GEI), acid detergent fiber intake (ADFI), acid detergent fiber intake/100 kg of live body weight (ADFI/100 kg LW), neutral detergent fiber intake (NDFI) and neutral detergent fiber intake/100 kg of live body weight (NDFI/100 kg LW) (Table 3).

Table 3. Performance of crossbred cattle finished in feedlot.

	Treatments				
Parameters	CON[a]	LS1[b]	LS2[c]	SE[d]	P<F
Initial body weight, kg	345	341	343	10.0	ns
Final body weight, kg	512	492	499	14.5	ns
Average daily gain, kg/day	1.60	1.40	1.50	0.08	ns
Dry matter conversion (DMC)	7.90	8.10	7.90	0.41	ns
Dry matter intake (DMI), kg/day	12.6	11.4	11.4	0.38	ns
DMI/live body weigh, %	2.94	2.70	2.70	0.08	ns
Crude protein intake, kg	1.30	1.20	1.10	0.04	ns
Gross energy intake, Mcal/day	54.9	52.1	51.8	1.73	ns
Acid detergent fiber intake (ADFI), kg	2.30	2.30	2.20	0.07	ns
ADFI/100 kg of live body weight, %	0.60	0.60	0.50	0.01	ns
Neutral detergent fiber intake (NDFI), kg	4.00	3.90	3.60	0.12	ns
NDFI /100 kg of live body weight, %	0.90	0.90	0.90	0.03	ns

[a]Control, [b]Soybean oil + linseed, [c]Soybean oil (60 d) + linseed (45 d), [d]Coefficient of variation.

The average of initial and final live body weight was 343 kg and 501 kg, respectively. Prado et al. (1995) reported 400 kg of final live body weight for Nellore steers. Furthermore, the average daily gain of 1.50 kg/day was satisfactory. Additionally, these results are consistent with Aferri et al. (2005) who reported the gain of 1.20 kg/day and similar to Beaulieu et al. (2002) who reported 1.50 kg/day for 102 days unlike the highest average gain of 2.00 kg/day reported by Andrae et al. (2000).

The feed conversion had an average of 8.00 kg of dry matter intake per kilogram of live body weight gain. This result is consistent with the mean of 9.00 kg reported by Abrahão et al. (2006) who fed 21-month-old Nellore heifers with linseed and canola grains, and Aferri et al. (2005) who reported the mean value of 8.09 kg.

The mean intake of dry matter and dry matter intake/live body weight was 11.8 kg/day and 2.80%, respectively. However, Aferri et al. (2005) reported 8.90 kg/day and 2.30%. Reduction of dry matter intake due to increases of fat in the beef cattle diet was not reported by Zinn et al. (2000) who detected mean values of 1.87% of dry matter intake/live body weight. Similar results were also observed by Prado et al. (1995) who reported 3.23% and 2.52% for 15.0% and 30.0% of cottonseed, respectively. On the other hand, Ngidi et al. (1990) found that the protected fat reduced the dry matter intake to 7.80 and 6.90 kg/animal/day for level of 4.00 and 6.00%, respectively.

The present results showed that soybean oil + linseed did not reduce dry matter intake and the animal performance. Positive effects on the animal performance occur because this diet offers no more than 7.00% of ether extract which avoids damages in cellulolytic activities of micro-organisms (VAN SOEST, 1994).

The mean value of crude protein intake was 1.20 kg/animal/day unlike 1.00 kg/animal/day reported by Abrahão et al. (2006). Such results were found satisfactory due to the animal performance in the present trial.

The mean values of acid detergent fiber intake and acid detergent fiber intake by 100 kg of live body weight was 2.30 kg/animal/day and 0.50%. Neutral detergent fiber intake and neutral detergent fiber intake by 100 kg of live body weight was 3.80 kg/animal/day and 0.90%, respectively.

Carcass evaluation

No difference (P>0.05) in hot carcass weight (HCW), carcass dressing (CD), fat thickness (FT), *Longissimus* area (LA) and *Longissimus* area/100 kg of carcass weight (LA/100 kg CW) were observed in this experiment (Table 4).

Table 4. Carcass evaluation of crossbred cattle finished in feedlot.

	Treatments				
Parameters	CON[a]	LS1[b]	LS2[c]	SE[d]	P<F
Hot carcass weight, kg	267	256	261	6.79	ns
Carcass dressing, %	52.7	52.1	52.3	0.47	ns
Fat thickness, mm	5.70	5.50	5.00	0.42	ns
Longissimus area, cm^2	92.2	87.2	84.7	3.53	ns
Longissimus area/100 kg	34.1	34.3	34.0	1.25	ns

[a]Control, [b]Soybean oil + linseed, [c]Soybean oil (60 d) + linseed (45 d), [d]Coefficient of variation.

Furthermore, there are various factors affecting the carcass dressing like breeds and feed components. The mean value of 52.4% was similar to Prado et al. (2008b) (52.2%), but different of Prado et al. (2000) (57.3%) and Abrahão et al. (2005) (54.8%).

Additionally, it was observed a mean value of 5.40 mm for fat thickness which is within Brazilian standards that range from 3.00 to 6.00 mm. Feeding has strongly been influencing the animal finishing because it affects the percentage of fat that accumulates into carcass and muscles. Consequently, animals submitted to different feeding levels and slaughtered at the same age have their carcasses with different fat content (WEBB, 2006; ROTTA et al., 2009b). The fat thickness acts like a thermal insulator protecting the carcass from cold shrinking during the cooling which requires a minimum of fat thickness to guarantee superior meat quality.

Satisfactory mean values of the *Longissimus* area (LA) and the *Longissimus* area/100 kg of carcass weight (LA/100 kg CW) was 88.0 cm^2 and 33.7, respectively. The mean values of the *Longissimus* area and the fat thickness are related to the quantity of muscles; consequently, high fat indicates less muscle and worst lean carcasses. Fat thickness has been the main external indicator of carcass finishing because it has been an important trait to determine the slaughtering age (WEBB, 2006).

Conclusion

The replacement of corn by soybean oil in conjunction with linseed grains did not affect the animal performance and the carcass characteristics of crossbred bulls (½ Nellore x ½ Simmenthal) finished in feedlot. If cost effective, soybean oil and linseed grains would be a feed alternative in beef cattle diets.

Acknowledgments

This study was supported by the Araucaria Foundation and Brazilian Council for Research and Technological Development (CNPq).

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