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Productive and economic performance of feedlot young Nellore bulls fed whole oilseeds

Heitor Henrique Costa Valeriano[1], Luís Carlos Vinhas Ítavo[1], Camila Celeste Brandão Ferreira Ítavo[1], Marina de Nadai Bonin Gomes[1], Alexandre Menezes Dias[1], Gelson dos Santos Difante[1], Vanessa Zirondi Longhini[1], Antonio Leandro Chaves Gurgel[2]*, Angelo Herbet Moreira Arcanjo[1], Manoel Gustavo Paranhos da Silva[1], Juliana Caroline Santos Santana[1], Jessika Rodrigues de Figueiredo Moura[1]

[1] Universidade Federal de Mato Grosso do Sul, Faculdade de Medicina Veterinária e Zootecnia, Campo Grande, MS, Brasil.
[2] Universidade Federal do Piauí, Campus Professora Cinobelina Elvas, Bom Jesus, PI, Brasil.

***Corresponding author:**
antonio.gurgel@ufpi.edu.br

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ABSTRACT - The effects of diets containing oilseeds were measured to evaluate the productive and economic parameters in the finishing of young, feedlot Nellore bulls. Twenty-four young Nellore bulls were used, with an initial body weight (BW) of 311.46±0.37 kg and 24 months of age, distributed into individual stalls (4 × 20 m) in a completely randomized design, totaling four treatments with six repetitions per treatment. Four diets (control, based on corn and soybean meal, and three diets containing cottonseed, soybean, and sunflower) were evaluated. Feed and orts were measured daily to calculate intake and costs. The dry matter intake of the control group was higher than soybean (10.64 kg/day), cotton (9.88 kg/day), and sunflower (9.30 kg/day) treatments, respectively. The cottonseed treatment showed the highest average neutral detergent fiber intake. There was a dietary effect of diets on average daily gain, total weight gain, and final weight. The soybean treatment showed the highest performance, total gain (232.55 kg), and final weight (544.38 kg). Oilseed intake can modify the fatty acids profile in the meat, decreasing its saturated fatty acid content. Whole soybean seed favors performance, improves feed efficiency, fatty acid profile, and fat distribution in the carcass, and can reduce production costs.

Keywords: cottonseed, economic yield, lipids, soybean, sunflower

1. Introduction

The use of lipids in ruminant feed has increased significantly in recent years as more has been learned about the use of sources that contain these nutrients (Millen et al., 2009; Silvestre and Millen, 2021). This was because lipids have about 2.25 times more energy than carbohydrates, which favors greater feed efficiency in the beef finishing system in feedlot (Souza et al., 2009; Rennó et al., 2015). However, the inclusion of lipids above the 70 g/kg of the dry matter (DM) limit of the diet can negatively affect the activity of cellulolytic bacteria, impairing fiber digestibility (NASEM, 2016), this effect being greater with the presence of unsaturated fatty acids (UFA) in the diet rather than saturated fatty acids (SFA; Blom and Brake, 2018), consequently reducing the animal's performance.

An efficient way to offer lipids to ruminants is in whole oilseeds as there is a slow release of lipids into the rumen by slow degradation and the need for regurgitation and rumination of the seeds

(Geron et al., 2012). The interior of the oilseed is surrounded by a protein matrix that protects it from a rapid release of lipid content into the rumen environment. It may decrease the adverse effects on ruminal fiber digestion (Rennó et al., 2015). In addition, oilseeds are rich in other nutrients important for animal nutrition, such as fiber, protein, minerals, and fat-soluble vitamins, and do not require processing for inclusion in the diet (NASEM, 2016; Valadares Filho et al., 2016).

Ítavo et al. (2021) mentioned that levels of sunflower seeds in diets containing up to 85 g/kg of lipid can be used without negative effects on intake, carcass, and meat quality of young Beefalo-Nellore bulls and heifers. The authors concluded that this can be an effective strategy to reduce the proportion of SFA and increase UFA in meat, which can be beneficial for human consumption.

Wanderley et al. (2022) found that oilseeds can alter the fatty acid (FA) profile in the milk of Girolando dairy cows and concluded that whole soybean provides greater milk and FA yields. In the same way, Rodrigues et al. (2022) found that lambs treated with whole soybean have greater amounts of FA, mostly UFA, in their meat. They cited a decrease in cholesterol levels in meat; thus, lambs fed soybean, producing FA, produced enriched meat that benefited human health.

Feeding represents the highest percentage of the total costs of animal production, especially when high performance is sought in the final stage of the production system, such as feedlot. In Brazil, oilseed production occurs in the same regions where the largest herds and feedlots of beef cattle are located. Because of this, they can be brought to maturity at a lower cost compared with other industrialized products used for the same purpose in ruminant production systems, such as protected fat in the form of calcium salts.

We tested the hypothesis that the inclusion of whole oilseeds in the diet of feedlot-finished cattle is an economically viable nutritional alternative due to the possibility of improving animal performance and feed efficiency. In this sense, this study aimed to evaluate the effect of lipid sources added to the diet on the productivity, economic performance, and carcass characteristics of Nellore cattle finished in feedlot.

2. Material and Methods

The experiment was carried out in Terenos, MS, Brazil (20°26'50.8" S, 54°50'21.5" W). The region has a tropical savanna climate, with a dry season ranging from three to five months (Alvares et al., 2013). Research on the animals was conducted according to the institutional committee on animal use (case no. 654/2015).

2.1. Animals, experimental design, and treatments

Twenty-four young uncastrated Nellore bulls (311.46±0.37 kg, 24 months of age) were used in this experiment. The animals were acquired from the beef cattle sector of the school farm of the Universidade Federal de Mato Grosso do Sul. The animals were kept confined in individual pens (4 × 20 m), without cover, with an unpaved floor, and were provided with individual feeders and automatic drinkers common to two pens with a capacity of 200 L. The animals were distributed among four treatments, which consisted of a base diet composed of whole millet plant silage as a forage source (*Pennisetum glaucum* (L.) R. Br.), a concentrate composed of soybean meal and ground corn, and a mineral mixture (treatment control). In addition, three diets were formulated that included whole oilseeds (cottonseed, soybean, and sunflower), with six replications each. The oilseed grains were included as whole seeds in the diets to achieve an ether extract (EE) concentration of 70 g/kg DM compared with an EE concentration of 24.7 g/kg DM for the control diet. However, the diets were isoproteic with 150 g/kg DM of crude protein (CP; Table 1).

The experimental period lasted 126 days and was preceded by an adaptation period of 21 days. At the beginning of the adaptation period, all animals were weighed, identified, and treated against ecto- and endoparasites (Doramectin 1%, Exceller, Vallé). The diets were offered once a day, on an *ad libitum* basis (target 50 g refusal/kg fed), and the amount offered was adjusted daily. Samples of the supplied feed and orts were collected weekly and frozen at −20 °C for further laboratory analysis.

Table 1 - Ingredients and composition of experimental diets containing different whole oilseeds

	Treatment			
	Control	Cottonseed	Soybean	Sunflower
Ingredient (g/kg)				
Whole millet plant silage	400.0	400.0	400.0	400.0
Corn ground	410.8	259.1	339.2	180.7
Soybean meal	174.2	73.5	0.0	135.5
Oilseed	-	252.3	242.2	268.8
Soybean oil	-	-	3.6	-
Mineral[1]	15.0	15.0	15.0	15.0
Chemical composition				
Dry matter (DM; g/kg)	508.9	511.1	511.0	510.7
Organic matter (g/kg DM)	946.9	944.8	946.9	939.6
Neutral detergent fiber (g/kg DM)	302.8	381.5	314.1	345.3
Crude protein (g/kg DM)	150.0	150.0	150.0	150.0
Ether extract (g/kg DM)	24.7	70.0	70.0	70.0
Fatty acids (g/kg DM)				
C14:0 (myristic acid)	0.2	0.6	0.3	0.1
C16:0 (palmitic acid)	3.6	13.5	8.5	4.9
C16:1 (palmitoleic acid)	0.2	0.5	0.3	0.2
C18:0 (stearic acid)	1.3	3.4	3.6	3.2
C18:1c-9 (oleic acid)	6.5	13.2	15.0	16.7
C18:2ωn-6 (linoleic acid)	9.1	32.6	31.5	39.4
C18:3ω-3 (linolenic acid)	0.1	0.9	3.5	0.6
Others	2.7	2.2	4.1	1.8
Σ Saturated	5.1	17.5	12.5	8.2
Σ Unsaturated	15.9	47.3	50.3	56.9

[1] Sodium, 100 g/kg; phosphorus, 88 g/kg; calcium, 176 g/kg; magnesium, 8 g/kg; sulphur, 22 g/kg; zinc, 3000 mg/kg; copper, 1000 mg/kg; cobalt, 80 mg/kg; iodine, 60 mg/kg; selenium, 20 mg/kg; fluorine, 880 mg/kg.

2.2. Chemical analysis

Samples of diets and orts were dried in a forced-ventilation oven at 55 °C for 72 h and then ground in a knife mill with a 1-mm sieve. Subsequently, the DM content was determined in an oven at 105 °C for 12 h, along with CP, EE, and neutral detergent fiber (NDF), according to the methodology described in Detmann et al. (2021).

2.3. Animal performance

The animals were weighed every 21 days, after 16 h of fasting from solids to evaluate the average daily weight gain (ADG). Total weight gain (TWG) was calculated by subtracting the final body weight (FBW) from the initial body weight. The ADG was calculated by dividing the TWG by the number of days between weighing events. The performance evaluation of the animals was based on the average daily diet intake and ADG in the experimental period.

2.4. Carcass characteristics

At the end of the experimental period, the animals were slaughtered in a commercial slaughterhouse. After slaughter, carcasses were identified and weighed to obtain hot carcass weight (HCW) and stored in a cold chamber at 4 °C for 24 h. After this period, carcass yield (CY) was evaluated and calculated based on HCW and FBW after the fasting period (CY = HCW/FBW*100). Subcutaneous fat thickness (SFT) was measured with a digital caliper, with measurements taken between the 12th and 13th ribs and in the croup in the *biceps femuris* muscle (SFTc). The loin eye area (LEA) was determined on the *longissimus thoracis* muscle. Measurements were made after a cross-section was cut between the 12th and 13th ribs and a transparent film was placed on the surface of the section so that the contour of the muscle could be traced. The drawings were processed in AUTOCAD® software (Autodesk, Inc. San Rafael, CA, USA).

The carcass evaluation was performed by visual observations by trained evaluators who assigned scores for finishing, fat distribution, and texture. The finish and fat distribution were evaluated considering the amount of subcutaneous fat measured in mm and transformed into a score as follows: 1 - absent (0 mm), 2 - scanty (1 to 3 mm), 3 - median (3 to 6 mm), 4 - uniform (6 to 10 mm), and 5 - excessive (> 10 mm). Meanwhile, the texture was evaluated using a scale from 1 to 5 as follows: 1 - very coarse, 2 - coarse, 3 - slightly coarse, 4 - fine, and 5 - very fine (Ramos and Gomide, 2007).

2.5. Fatty acids profile

The FA profile was carried out according to Miyaki et al. (2022). The samples of *longissimus thoracis* muscle were excised at a thickness of 2.5 from the left half of the carcass after 24 h at 0 °C. Lipid extraction was performed following the methods of Folch et al. (1957). The lipid extracts were converted to fatty acid methyl esters (FAME) using a solvent system that extracts neutral and phospholipids proposed by Nürnberg et al. (2007). For the gas chromatography (GC Thermo Trace GC Ultra, with column SP-2560, Merck/Sigma-Aldrich, Supelco®, Bellefonte, PA, USA), the oven was set as follows: 100 °C, 5 min hold, ramp 4 °C/min to 220 °C, 30 min hold; post run: maximum ramp up to 100 °C, 5 min hold. Helium was used as a carrier gas at a flow rate of 1.3 mL/min. The split ratio was 1:10, and the injector and detector temperatures were 260 °C. The FAME were identified by a comparison of the FAME retention times with those of authentic standards (FAME mix components, Supelco®, Bellefont, PA, USA) following the same injection method. The concentrations of SFA, UFA, monounsaturated fatty acids (MUFA), and polyunsaturated fatty acids (PUFA) were calculated based on the FA profile.

2.6. Costs evaluation

Feed costs were calculated considering the price of each ingredient. The values of feed used (US$/ton.) were US$ 89.24/ton for millet silage, US$ 115.69/ton for corn, US$ 308.53/ton for soybean meal, US$ 202.09/ton for cottonseed, US$ 329.08/ton for soybean, and US$ 323.78/ton for sunflower.

The gross revenue, daily costs, total costs, and gross margin were calculated using the equations:

Revenue (US$) = HCW × Value kg (US$);

Daily cost (US$) = Cost of all ingredients in the diet (US$) × consumption (kg/day);

Total cost (US$) = Daily intake (kg) × feedlot days × daily cost (US$);

Margin (US$/animal) = Revenue (US$) – Total cost (US$/animal)

The exchange rate of US$ in R$ was considered at the time of marketing of inputs and slaughter of animals in 2017 (RS$ 3.17/US$).

2.7. Statistical analysis

For the statistical analysis, data were analyzed for variance using a randomized design with four treatments and six replications per treatment, considering three degrees of freedom for the treatment effect, 20 degrees of freedom for the residue, and 23 degrees of freedom for the total. The animal was considered an experimental unit. The statistical model used was:

$$Y_{ij} = \mu + t_i + e_{ij},$$

in which Y_{ij} = observed value in treatment i and repetition j, μ = overall mean, t_i = treatment effect (i = oilseeds), and e_{ij} = random error associated with each observation.

The means were compared by Tukey's test at a 5% significance level. Data analyses were performed using the SAS PROC GLM statistical package (Statistical Analysis System, University Edition).

3. Results

There was a significant effect (P<0.05) of diets on nutrient intake (Table 2). The highest average DM intake (DMI) was registered for the animals that received the control diet (10.90 kg/day), followed by those that received soybean (10.64 kg/day), cottonseed (9.88 kg/day), and sunflower (9.30 kg/day). Likewise, the effect of treatments on organic matter intake (P<0.05) was also observed, with a higher value in the control group (10.32 kg/day), followed by treatments with soybean (10.08 kg/day), cotton seed (9.33 kg/day), and sunflower (8.74 kg/day). Animals treated with cottonseed showed higher (P<0.05) NDF intake (3.77 kg/day), while the lowest intake was registered in the control group (3.30 kg/day). There was a significant effect (P<0.05) of diets on CP and EE intake. There was a higher EE intake in the soybean treatment and a higher CP intake in the control treatment (Table 2).

A significant effect of diet on ADG, TWG, and FBW was observed (P<0.05) (Table 3). Animals that consumed soybean had the greatest ADG (1.58 kg/day), TWG (232.55 kg), and FBW (544.38 kg), while those of the sunflower treatment had the lowest averages for these same variables (1.21 kg/day, 177.33 kg, and 488.67 kg, respectively).

The CY, SFT, and SFTc of animals on the control diet were higher than those of the animals that received diets with oilseeds (P<0.05), except for soybean treatment. The HCW (kg/animal) of animals

Table 2 - Nutrient intake of feedlot cattle fed diets containing different whole oilseeds

	Treatment				SEM	P-value
	Control	Cottonseed	Soybean	Sunflower		
Nutrient intake (kg/day)						
Dry matter	10.9a	9.9c	10.6b	9.3d	0.349	0.0001
Organic matter	10.3a	9.3c	10.1b	8.7d	0.332	0.0001
Neutral detergent fiber	3.3c	3.8a	3.3bc	3.4b	0.116	0.0001
Crude protein	1.6a	1.5c	1.6b	1.4d	0.052	0.0001
Ether extract	0.3d	0.7b	0.7a	0.6c	0.043	0.0001
Nutrient intake (% BW)						
Dry matter	2.6a	2.4c	2.5b	2.3c	0.088	0.0001
Neutral detergent fiber	0.8c	0.9a	0.8c	0.8b	0.029	0.0001

SEM - standard error of the mean; BW - body weight.
Means followed by a lowercase letter in the same row differ from each other by Tukey's test (P<0.05).

Table 3 - Productive performance of feedlot cattle fed diets containing different whole oilseeds

	Treatment				SEM	P-value
	Control	Cottonseed	Soybean	Sunflower		
Final BW (kg)	520.0ab	522.7ab	544.4a	488.7b	7.978	0.0459
TWG (kg)	208.3ab	211.7ab	232.5a	177.3b	7.212	0.0175
ADG (kg/day)	1.4ab	1.4ab	1.6a	1.2b	0.047	0.0085
CY (%)	51.8a	48.4b	49.0b	48.1b	0.435	0.0004
HCW (kg/animal)	267.8a	252.8ab	267.0a	235.1b	4.514	0.0063
LEA (cm^2)	63.5	62.5	63.8	58.3	1.869	0.6629
SFT (mm)	4.7a	2.4b	3.3ab	2.4b	0.295	0.0011
SFTc (mm)	6.5a	4.8b	6.2a	4.0b	0.205	0.0001

BW - body weight; TWG - total weight gain; ADG - average daily gain; CY - carcass yield; HCW - hot carcass weight; SFT - subcutaneous fat thickness; SFT - subcutaneous fat thickness measured in the croup in the *biceps femuris* muscle; LEA - loin eye area; SEM - standard error of the mean.
Means followed by a lowercase letter on the same row differ from each other by Tukey's test (P<0.05).

of the control and soybean treatments was statistically similar, being higher than that of the animals fed sunflower or cottonseed diet. The LEA was not influenced (P>0.05) by the treatments (Table 3).

Despite STF having not presented an effect of oilseeds, there was a significant effect of diet (P<0.05) on the FA in the meat of the young bulls fed oilseeds (Table 4). The oilseed intake influenced the concentration of SFA, UFA, MUFA, and PUFA in meat. The highest concentration of SFA was observed in the meat of cattle that received cottonseed (633.9 g/kg), while the lowest concentrations were observed in the meat of animals that received soybean (557.4 g/kg) and sunflower (555.4 g/kg) in the diet. There was a significant effect of diet (P<0.05) on UFA concentration in the meat. The animals that were treated with soybean and sunflower presented the highest UFA concentrations. The MUFA concentration was highest in the soybean treatment, while PUFA concentration was higher in the meat of young bulls in the sunflower treatment (Table 4).

There was a significant effect of diet on the finishing qualitative carcass characteristics (P<0.05). The carcass finishing of animals in the control treatment was higher than that of animals in treatments with oilseeds. There was no significant effect of diets (P>0.05) on carcass and hindquarter fat distribution and on fat texture (Table 5).

The gross income of the control diet and diets with the inclusion of soybeans had similar values (a difference of only 0.3%) and were superior to diets with cottonseed and sunflower seeds (Table 6).

Table 4 - Sum of fatty acids in meat of feedlot cattle fed diets containing different whole oilseeds (g/kg)

	Treatment				SEM	P-value
	Control	Cottonseed	Soybean	Sunflower		
∑ SFA	570.7b	633.9a	557.4c	555.4c	22.7	0.0353
∑ UFA	429.3b	366.1c	442.6a	444.6a	7.2	0.0090
∑ MUFA	283.1b	226.6c	302.5a	241.7c	9.7	0.0030
∑ PUFA	144.7b	126.7c	137.8b	190.1a	4.5	0.0151

∑ SFA - sum of saturated fatty acids in meat; ∑ UFA - sum of unsaturated fatty acids in meat; ∑ MUFA - sum of monounsaturated fatty acids in meat; ∑ MUFA - sum of polyunsaturated fatty acids in meat; SEM - standard error of the mean.
Means followed by a lowercase letter in the same row differ from each other by Tukey's test (P<0.05).

Table 5 - Qualitative evaluation (points) of finishing fat distribution and fat texture of feedlot cattle fed diets containing different whole oilseeds

	Treatment				SEM	P-value
	Control	Cottonseed	Soybean	Sunflower		
Finishing	3.0a	2.2b	2.7ab	2.2b	0.114	0.0026
Fat in the carcass	1.8	1.3	2.3	2.0	0.152	0.0678
Fat in the rear	2.2	1.7	2.0	1.6	0.123	0.1671
Texture	4.3	4.2	4.5	4.1	0.065	0.0846

SEM - standard error of the mean.
Means followed by a lowercase letter in the same row differ from each other by Tukey's test (P<0.05).

Table 6 - Cost of diets containing different whole oilseeds

	Treatment				SEM	P-value
	Control	Cottonseed	Soybean	Sunflower		
Revenue (U$/animal)	760.6a	718.0b	758.0a	673.7c	10.6	0.0001
Costs						
Daily costs (US$/day)	2.4a	2.2c	2.3b	2.4b	0.013	0.0001
Total costs (US$/animal)	350.5a	322.8b	345.4a	354.1a	4.9	0.0464
Margin (US$/animal)	410.0a	395.2b	412.7a	313.2c	5.7	0.0001

SEM - standard error of the mean.
Means followed by a lowercase letter in the same row differ from each other by Tukey's test (P<0.05).

Feeding expenses per day (US$/day) and per animal (US$/animal) were higher with the diet with sunflower, followed by the control, soybean, and cotton diets. The highest gross margin was obtained in the treatment with soybean inclusion and the lowest in the treatment with sunflower (Table 6).

4. Discussion

Despite the fact that the lipid content in the diets with oilseeds inclusion did not exceed 70 g/kg, which is a limit established for cattle, so that there are no adverse effects on intake (NASEM, 2016; Kozloski, 2011), there was a reduction on DMI in all oilseed diets. Nevertheless, lipids are advantageous in diets due to their high energy value, which should be used without harmful effects of FA on rumen fermentation (Ítavo et al., 2005) with possible modification of FA in meat (Ítavo et al., 2021; Miyaki et al., 2022; Rodrigues et al., 2022) and in milk (Wanderley et al., 2022).

The decrease in feed intake may be related to the lipid content in diets containing oilseeds, with possible adverse effects on digestion of the fibrous portion of the diet and, probably, an increase in the length of stay and filling of the rumen environment, consequently reducing the ingestion. Lipids can alter ruminal fermentation, and structural carbohydrate degradation (Jenkins and Palmquist, 1984). Another lipid effect is the alteration of the microbiota ruminal into almost 50% of the diversity of fermentative bacteria (Melo et al., 2022; Melo et al., 2023). Bassi et al. (2012) evaluated 60 g/kg of EE including soybean, cottonseed, and flaxseed as sources of lipids diet, and also observed higher DMI in animals that consumed a diet without oilseeds.

Another approach to the reasons for reducing the DMI is the NDF intake, although, in relation to body weight, NDF intake did not exceed 1% BW. According to Mertens (1987), when intake is limited by physical factors, NDF intake remains close to 1.2% BW. Consequently, we can infer that there was probably energy regulation of nutrient intake under the conditions of this experiment. The higher NDF intake promoted by the diet with cottonseed is due to the higher concentration of NDF in this ingredient since the cottonseed has fiber residues adhered to the seed surface. Because of this, cottonseed and its byproducts are sources of fiber included in the diet for finishing beef cattle in feedlots (Goulart et al., 2020a,b; Silvestre and Millen, 2021; Arcanjo et al., 2022; Arcanjo et al., 2023).

It is likely that the best performance results observed in the diet with soybean are related to nutrient intake and quality that can promote better feed efficiency (Souza et al., 2009; Bassi et al., 2012). Rennó et al. (2015) observed a decrease in DMI with an increase in soybean supply, without reducing the ADG of finishing Nellore young bulls. The results were attributed to the fact that the use of soybean in the diets favored feed efficiency and digestibility (Oliveira et al., 2020).

Wanderley et al. (2021) also studied the inclusion of oilseeds (cotton, sunflower, and soybean) to obtain diets with 70 g/kg of lipids for lactating cows and observed that the inclusion of oilseeds reduced the digestibility of DM and organic matter. The authors did not observe any difference between the DMI and milk yield of the control diet (without oilseeds) and the diet with soybean. However, they also detected a reduction in DMI and milk production in cows fed a diet containing cottonseed. The justification was based on the fact that the DM digestibility of cottonseed was of 23%, while the digestibility of soybeans was of 56% (Wanderley et al., 2021).

The carcass yield of animals fed diets containing oilseeds was lower than that of animals in the control group, which suggests that the surplus amount of lipids in the diets may have been directed toward the deposition of mesenteric fat, since the animals in the diets containing oilseeds had lower CY and SFT than the animals in the control diet. This is also reflected in the lower degree of carcass finishing of the animals that received oilseeds in the diet. Cirne et al. (2020), when evaluating diets rich in concentrate with whole cottonseed for Dorper × Santa Inês lambs, found higher carcass weight and hot carcass yield in lambs fed the control diet compared with those fed diets with cottonseed. The same authors also did not find differences in LEA and SFT between the evaluated treatments. Rodrigues et al. (2022), working with the inclusion of oilseeds (soybean and cottonseed) in the finishing diet of feedlot lambs, observed lower CY of the animals that consumed cottonseed.

The FA in the meat of young bulls fed oilseeds were altered by diet. Oilseeds in the diets of beef cattle (Ítavo et al., 2021) and lambs (Rodrigues et al., 2022) can alter the FA profile in meat and milk (Wanderley et al., 2022; Rufino et al., 2023). The supplementation with oilseeds increases the health-promoting index of milk and meat since its use can reduce SFA and increase PUFA in animal products.

The revenues showed only a 0.3% difference between the control diet and the soybean treatment. This result is mainly related to the fact that the carcasses of animals from the control and soybean treatments had higher HCW and also higher CY in the control group. Feeding expenses per day (US$/day) and per animal (US$/animal) were higher in the diet with sunflower, followed by the control, soybean, and cotton treatments. The higher cost of the diet containing sunflower is related to the acquisition cost of this grain, which was the highest among the acquired grains, and even though this was the treatment that registered the lowest DMI, the value of the grains increased the daily diet. The costs per carcass produced were similar among the control, cotton, and soybean treatments, possibly because these costs are related to the ADG, which had no difference among these treatments, and were higher than the sunflower, which, in addition to presenting lower ADG, was the most expensive whole grain.

The highest gross margin was obtained in the treatment with soybean inclusion and the lowest in the treatment with sunflower seed; the control and cotton treatment recorded intermediate values. The lower margin recorded in the sunflower treatment was due to the lower performance and higher cost per arroba (15 kg of carcass) of the animals in this treatment. Finally, the diet with cottonseed had the highest gross margin; however, the animals were slaughtered 20 kg lighter than those in the soybean treatment, which had the second-highest gross margin.

The lower costs obtained with the use of cottonseed are due to the fact that this product is offered in the Center-West region of Brazil, where most of the cotton farming is located (CONAB, 2022), and there is an availability of this co-product for beef cattle feedlot systems. In addition to higher revenue, soybean had lower costs than control and sunflower treatments, since there is a large supply in the market, with Brazil being the largest producer in the world and the main production concentrated in the Midwest region (CONAB, 2022; USDA, 2022).

5. Conclusions

The use of whole soybean seed in the diet of young bulls finished in feedlot provides greater performance and better distribution of fat in the carcass, in addition to lower production costs.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Conceptualization: H.H.C. Valeriano, L.C.V. Ítavo and C.C.B.F. Ítavo. Data curation: L.C.V. Ítavo and M.N.B. Gomes. Formal analysis: L.C.V. Ítavo and A.L.C. Gurgel. Funding acquisition: L.C.V. Ítavo, C.C.B.F. Ítavo and A.M. Dias. Investigation: H.H.C. Valeriano, L.C.V. Ítavo, M.N.B. Gomes, A.M. Dias, G.S. Difante and V.Z. Longhini. Methodology: H.H.C. Valeriano, L.C.V. Ítavo, C.C.B.F. Ítavo, M.N.B. Gomes, A.M. Dias, G.S. Difante, V.Z. Longhini, A.H.M. Arcanjo, M.G.P. Silva, J.C.S. Santana and J.R.F. Moura. Project administration: H.H.C. Valeriano, L.C.V. Ítavo, C.C.B.F. Ítavo, M.N.B. Gomes, A.M. Dias, G.S. Difante and V.Z. Longhini. Resources: L.C.V. Ítavo, C.C.B.F. Ítavo, M.N.B. Gomes and A.M. Dias. Software: L.C.V. Ítavo and A.L.C. Gurgel. Supervision: H.H.C. Valeriano, L.C.V. Ítavo, C.C.B.F. Ítavo, M.N.B. Gomes, A.M. Dias, G.S. Difante and V.Z. Longhini. Validation: H.H.C. Valeriano, L.C.V. Ítavo, C.C.B.F. Ítavo, A.H.M. Arcanjo, M.G.P. Silva, J.C.S. Santana and J.R.F. Moura. Visualization: H.H.C. Valeriano, L.C.V. Ítavo, M.N.B. Gomes, A.H.M. Arcanjo, M.G.P. Silva, J.C.S. Santana and J.R.F. Moura. Writing – original draft: H.H.C. Valeriano, L.C.V. Ítavo, A.L.C. Gurgel, A.H.M. Arcanjo, M.G.P. Silva, J.C.S. Santana and J.R.F. Moura. Writing – review & editing: H.H.C. Valeriano, L.C.V. Ítavo, A.L.C. Gurgel, A.H.M. Arcanjo, M.G.P. Silva, J.C.S. Santana and J.R.F. Moura.

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References

Alvares, C. A.; Stape, J. L.; Sentelhas, P C.; Gonçalves, J. L. M. and Sparovek, G. 2013. Köppen's climate classification map for Brazil. Meteorologische Zeitschrift 22:711-728. https://doi.org/10.1127/0941-2948/2013/0507

Arcanjo, A. H. M.; Ítavo, L. C. V.; Ítavo, C. C. B. F.; Franco, G. L.; Dias, A. M.; Difante, G. S.; Lima, E. A.; Santana, J. C. S. and Gurgel, A. L. C. 2022. Cotton cake as an economically viable alternative fibre source of forage in a high-concentrate diet for finishing beef cattle in feedlots. Tropical Animal Health and Production 54:112. https://doi.org/10.1007/s11250-022-03120-y

Arcanjo, A. H. M.; Ítavo, L. C. V.; Ítavo, C. C. B. F.; Dias, A. M.; Difante, G. S.; Franco, G. L.; Longhini, V. Z.; Gomes, F. K.; Ali, O.; Santana, J. C. S.; Gurgel, A. L. C.; Candido, A. R. and Costa, C. M. 2023. Effectiveness of cottonseed cake fibre included in the diet of Nellore steers finished in confinement. New Zealand Journal of Agricultural Research, https://doi.org/10.1080/00288233.2022.2161096

Bassi, M. S.; Ladeira, M. M.; Chizzotti, M. L.; Chizzotti, F. H. M.; Oliveira, D. M.; Machado Neto, O. R.; Carvalho, J. R. R. and Nogueira Neto, A. A. 2012. Grãos de oleaginosas na alimentação de novilhos zebuínos: consumo, digestibilidade e desempenho. Revista Brasileira de Zootecnia 41:353-359. https://doi.org/10.1590/S1516-35982012000200018

Blom, E. J. and Brake, D. W. 2018. Effects of intake of linseed oil or tallow on nutrient digestion and nitrogen balance of beef steers consuming diets based on dry-rolled corn. The Professional Animal Scientist 34:447-459. https://doi.org/10.15232/pas.2018-01759

Cirne, L. G. A.; Carvalho, G. G. P.; Viana, P. T.; Luz, Y. S.; Reis, M. J. S.; Figueiredo, M. P.; Assis Neto, D. Y. C.; Azêvedo, J. A. G.; Pina, D. S. and Freitas Júnior, J. E. 2020. Impact of high-concentrate diets with cottonseed associated with calcium lignosulfonate on the metabolic, productive, and carcass characteristics of feedlot lambs. Tropical Animal Health and Production 52:1821-1832. https://doi.org/10.1007/s11250-019-02194-5

CONAB - Companhia Nacional de Abastecimento. 2022. Acompanhamento da Safra Brasileira. Available at: <https://www.conab.gov.br>. Accessed on: Sept. 13, 2022.

Detmann, E.; Costa e Silva, L. F.; Rocha, G. C.; Palma, M. N. N. and Rodrigues, J. P. P. 2021. Métodos para análise de alimentos. 2.ed. Suprema, Visconde do Rio Branco. 350p.

Folch, J.; Lees, M. and Stanley, G. H. S. 1957. A simple method for the isolation and purification of total lipides from animal tissues. Journal of Biological Chemistry 226:497-509. https://doi.org/10.1016/S0021-9258(18)64849-5

Geron, L. J. V.; Mexia, A. A.; Garcia, J.; Silva, M. M. and Zeoula, L. M. 2012. Concentrate supplementation in lambs finished at pasture on cost of production in the dry season. Semina: Ciências Agrárias 33:797-808. https://doi.org/10.5433/1679-0359.2012v33n2p797

Goulart, R. S.; Vieira, R. A. M.; Daniel, J. L. P.; Amaral, R. C.; Santos, V. P.; Toledo Filho, S. G.; Cabezas-Garcia, E. H.; Tedeschi, L. O. and Nussio, L. G. 2020a. Effects of source and concentration of neutral detergent fiber from roughage in beef cattle diets: comparison of methods to measure the effectiveness of fiber. Journal of Animal Science 98:skaa108. https://doi.org/10.1093/jas/skaa108

Goulart, R. S.; Vieira, R. A. M.; Daniel, J. L. P.; Amaral, R. C.; Santos, V. P.; Toledo Filho, S. G.; Cabezas-Garcia, E. H.; Tedeschi, L. O. and Nussio, L. G. 2020b. Effects of source and concentration of neutral detergent fiber from roughage in beef cattle diets on feed intake, ingestive behavior, and ruminal kinetics. Journal of Animal Science 98:skaa107. https://doi.org/10.1093/jas/skaa107

Ítavo, C. C. B. F.; Ítavo, L. C. V.; Silva, F. F.; Veloso, C. M. and Oliveira, R. L. 2005. Aspectos da fermentação ruminal de lipídios. p.151-169. In: Nutrição de ruminantes: Aspectos relacionados à digestibilidade e aproveitamento de nutrientes. Ítavo, L. C. V. and Ítavo, C. C. B. F., eds. Editora UCDB, Campo Grande.

Ítavo, L. C. V.; Ítavo, C. C. B. F.; Dias, A. M.; Gomes, M. N. B.; Silva, A. G.; Leal, E. S.; Pereira, M. W. F.; Pereira, C. S. and Santos, G. T. 2021. Lipid rich diet from sunflower seeds can alter the proportion of fatty acids on hybrid Beefalo × Nellore cattle. Tropical Animal Health and Production 53:162. https://doi.org/10.1007/s11250-021-02615-4

Jenkins, C. and Palmquist, D. L. 1984. Effect of fatty acids or calcium soaps on rumen and total nutrient digestibility of dairy rations. Journal of Dairy Science 67:978-986. https://doi.org/10.3168/jds.S0022-0302(84)81396-X

Kozloski, G. V. 2011. Bioquímica dos ruminantes. 3.ed. Editora UFSM, Santa Maria.

Melo, H. S. A.; Ítavo, L. C. V.; Castro, A. P.; Ítavo, C. C. B. F.; Caldas, R. A.; Mateus, R. G.; Niwa, M. V. G.; Moraes, G. J.; Zornitta, C. S.; Gurgel, A. L. C. and Benchaar, C. 2022. Bacterial species in the ruminal content of steers fed oilseeds in the diet. Tropical Animal Health and Production 54:396. https://doi.org/10.1007/s11250-022-03399-x

Melo, H. S. A.; Ítavo. L. C. V.; Castro, A. P.; Ítavo, C. C. B. F.; Caldas, R. A.; Mateus, R. G.; Niwa, M. V. G.; Moraes, G. J.; Zornitta, C. S.; Gurgel, A. L. C. and Benchaar, C. 2023. Effect of whole oilseeds in the diet on bacterial diversity in the solid fraction of the ruminal content of steers. Tropical Animal Health and Production 55:32. https://doi.org/10.1007/s11250-022-03442-x

Mertens, D. R. 1987. Predicting intake and digestibility using mathematical models of ruminal function. Journal of Animal Science 64:1548-1558. https://doi.org/10.2527/jas1987.6451548x

Millen, D. D.; Pacheco, R. D. L.; Arrigoni, M. D. B.; Galyean, M. L. and Vasconcelos, J. T. 2009. A snapshot of management practices and nutritional recommendations used by feedlot nutritionists in Brazil. Journal of Animal Science 87:3427-3439. https://doi.org/10.2527/jas.2009-1880

Miyaki, S.; Ítavo, L. C. V.; Duarte, M. T.; Valeriano, H. H. C.; Pereira, M. W. F.; Araújo, T. L. A. C.; Ítavo, C. C. B. F.; Gomes, R. C. and Bonin, M. N. 2022. The effect of dietary oilseeds on physico-chemical characteristics, fatty acid profile and sensory aspects of meat of young zebu cattle. Food Science and Technology 42:e21421. https://doi.org/10.1590/fst.21421

NASEM - National Academies of Sciences, Engineering, and Medicine. 2016. Nutrient requirements of beef cattle. 8th ed. The National Academies Press, Washington, DC. https://doi.org/10.17226/19014

Nürnberg, K.; Dannenberger, D.; Ender, K. and Nürnberg, G. 2007. Comparison of different methylation methods for the analysis of conjugated linoleic acid isomers by silver ion HPLC in beef lipids. Journal of Agricultural and Food Chemistry 55:598-602. https://doi.org/10.1021/jf061865k

Oliveira, R. T.; Goes, R. H. T. B.; Gandra, J. R.; Sabedot, M. A.; Osmari, M. P.; Silva, N. G.; Anschau, D. G.; Oliveira, S. S. and Picanço, Y. S. 2020. Intake, digestibility and recovery of grains from feces of steers fed different oilseeds. Revista Brasileira de Saúde e Produção Animal 21:e2121272020. https://doi.org/10.1590/S1519-99402121272020

Ramos, E. M. and Gomide, L. A. M. 2007. Textura e maciez da carne. p.375-454. In: Avaliação da qualidade de carnes. Fundamentos e metodologias. Ramos, E. M.; Gomide, L. A. M., eds. UFV, Viçosa, MG.

Rennó, F. P.; Cônsolo, N. R. B.; Barletta, R. V.; Ventureli, B.; Gardinal, R.; Takiya, C. S.; Gandra, J. R. and Pereira, A. S. C. 2015. Grão de soja cru e inteiro na alimentação de bovinos: Excreção de grão de soja nas fezes. Archivos de Zootecnia 64:331-338. https://doi.org/10.21071/az.v64i248.417

Rodrigues, B. J.; Ítavo, C. C. B. F.; Ítavo, L. C. V.; Gomes, M. N. B.; Difante, G. S.; Arco, T. F. F. S.; Gurgel, A. L. C.; Higano, L. M.; Godoy, C.; Miguel, A. A. S.; Souza, G. V.; Luz, R. C. S. and Brixner, B. M. 2022. The lipid source can modify saturated and unsaturated fatty acids profile of meat of lambs. Food Science and Technology 42:e91721. https://doi.org/10.1590/fst.91721

Rufino, M. O. A.; Salles, M. S. V.; Negrão, J. A.; Gurgel, A. L. C.; Daniel, J. L. P.; Lima, L. S.; Marchi, F. E.; Roma Júnior, L. C. and Santos, G. T. 2023. Oxidative stability of milk and expression of oxidative stress response, lipogenic-related, and IGF-1 genes in early-lactation cows supplemented with peanut and sunflower oils. Animal Production Science 63:535-543. https://doi.org/10.1071/AN22273

Silvestre, A. M. and Millen, D. D. 2021. The 2019 Brazilian survey on nutritional practices provided by feedlot cattle consulting nutritionists. Revista Brasileira de Zootecnia 50:e20200189. https://doi.org/10.37496/rbz5020200189

Souza, A. R. D. L.; Medeiros, S. R.; Morais, M. G.; Oshiro, M. M. and Torres Júnior, R. A. A. 2009. Dieta com alto teor de gordura e desempenho de tourinhos de grupos genéticos diferentes em confinamento. Pesquisa Agropecuária Brasileira 44:746-753. https://doi.org/10.1590/S0100-204X2009000700015

USDA - United States Department of Agriculture. 2022. World agricultural production. p.1-37. Available at: <https://apps.fas.usda.gov/psdonline/circulars/production.pdf>. Accessed on: Oct. 08, 2022.

Valadares Filho, S. C.; Costa e Silva, L. F.; Lopes, S. A.; Prados, L. F.; Chizzotti, M. L.; Machado, P. A. S.; Bissaro, L. Z. and Furtado, T. 2016. BR-CORTE 3.0: Cálculo de exigências nutricionais, formulação de dietas e predição de desempenho de zebuínos puros e cruzados. UFV, Viçosa, MG.

Wanderley, A. M.; Ítavo, L. C. V.; Santos, G. T.; Ítavo, C. C. B. F.; Cunha, C. S.; Difante, G. S.; Dias, A. M.; Mateus, R. G. and Oliveira, M. V. M. 2021. Ruminal degradation kinetics of diets with different lipid sources and its influence on intake and milk yield of early lactation crossbred Holstein × Gir cows. Tropical Animal Health and Production 53:516. https://doi.org/10.1007/s11250-021-02960-4

Wanderley, A. M.; Ítavo, L. C. V.; Santos, G. T.; Ítavo, C. C. B. F.; Dias, A. M.; Difante, G. S.; Gurgel, A. L. C.; Cunha, C. S.; Mateus, R. G.; Cardoso, C. A. L. and Oliveira, M. V. M. 2022. Sources of polyunsaturated fatty acids from oilseeds in dairy cows diets can alter yield of and fatty acid profile in milk. Food Science and Technology 42:e119021. https://doi.org/10.1590/fst.119021