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Introduction of sugar cane bagasse pellets in diets devoid of long fiber for feedlots finished steers

Inclusão de bagaço de cana-de-açúcar peletizado em dietas desprovidas de fibra longa para tourinhos terminados em confinamento

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Abstract

The use of diets without roughage in beef feedlot has become common in recent years due to practicality, feasibility and availability of inputs. However, the introduction of roughage that does not harm the operation of the feeding management can bring health benefits to animals and economic gain. This study aimed to evaluate the productive and economic performance of steers finished in feedlot, fed three levels of sugar cane bagasse pellets (SBP) in diets without long-fiber. The treatments consisted of 0%, 7% and 14% of SBP in a mixture of concentrate, comprising 80% whole corn grain plus 20% of a protein core. The experimental design was completely randomized with four replications. The diet with 0% of SBP promoted lower dry matter intake and weight gain. Feed conversion was similar between treatments, with an average of 6.21 kg-1. The lower dry matter digestibility was found in the diet with 14% of SBP. The introduction of SBP did not change the rumination, averaging 1.9 hours day-1. Animals fed 7% of SBP showed higher fat thickness. Due to the numerical differences between treatments for feed conversion in housing and daily cost of food, the profit margin was maximal in the diet with 0% of SBP, with values of R$ 338.1; R$ 311.6 and R$ 305,1 per animal, respectively 0%, 7% and 14% of SBP. The introduction of SBP promoted improvements in production performance, but did not improve the economic results of steers finished in feedlot.
Key words: 100% concentrate diet. All concentrate diet. Co-products. High-grain diet. Whole corn grain.

Resumo

O uso de dietas sem volumoso no confinamento de bovinos tornou-se comum nos últimos anos devido à praticidade, viabilidade e disponibilidade de insumos. Entretanto, a inclusão de um volumoso que

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não prejudique a operacionalidade do manejo alimentar pode trazer benefícios sanitários aos animais e ganho econômico. Objetivou-se avaliar o desempenho produtivo e econômico de tourinhos terminados em confinamento, alimentados com três teores de pellets de bagaço de cana-de-açúcar (PBC) em dietas sem fibra longa. Os tratamentos eram compostos por 0%, 7% e 14% de PBC em uma mistura de alimentos concentrados, composta por 80% de grãos de milho inteiro mais 20% de um núcleo proteico. O delineamento experimental foi inteiramente ao acaso com quatro repetições. A dieta com 0% de PBC promoveu menor consumo de matéria seca e ganho de peso vivo. A conversão alimentar foi semelhante entre os tratamentos, apresentando média de 6,21 kg kg^{-1}. A menor digestibilidade da matéria seca foi encontrada na dieta com 14% de PBC. A inclusão de PBC não alterou o tempo de ruminação, com média de 1,9 horas dia^{-1}. Animais alimentados com 7% de PBC apresentaram maior espessura de gordura. Devido às diferenças numéricas entre os tratamentos para a conversão alimentar em carcaça e custo diário com alimentação, a margem de lucro foi máxima na dieta com 0% de PBC, apresentando valores de R$338,1; R$311,6 e R$305,1 por animal, respectivamente para 0%, 7% e 14% de PBC. A inclusão de PBC promoveu melhorias no desempenho produtivo, porém não melhorou o resultado econômico de tourinhos terminados em confinamento.
Palavras-chave: Dieta 100% concentrado. Dieta de alto grão. Dieta totalmente concentrada. Coprodutos. Grão de milho inteiro.

Introduction

The diet composition of Brazilian beef cattle has seen an increase in proportion of food concentrates in the past years, reflecting the relationship between the prices of commodities involved in feedlot operations. From 2010 onwards, the association between corn and fat beef was so favorable that the use of diets lacking roughage, where corn makes up the majority of the feed, became popular.

Non-roughage diets, with whole corn grains (WCG), are more commonly found in feedlots of the United States, Argentina and Uruguay, used when the market is favorable, when labor barriers are found or upon shortage of forage. According to Turgeon et al. (2010), introducing roughage reduces the diet's energetic density, increases the cost per unit of metabolizable energy, and complicates the feeding operation and feedlot management. Nevertheless, roughage is provided in finishing diets, even if in small quantities (<10% of the diet), to maintain the rumen's health and to reduce the incidence of digestive disorders, such as bloat, acidosis, liver abscess and laminitis.

Roughage is the main responsible for ensuring the suitability of the diet's physical characteristics. In beef cattle, one important indicator in this context is the effective neutral detergent fiber (NDFe), which is the remaining percentage of neutral detergent fiber (NDF) that is retained in a 1.18-millimeter sieve. NDFe is the NDF fraction capable of stimulating salivation, chewing, rumination and rumen motility, which is responsible for maintaining the ruminal pH and health (PITT et al., 1996).

The levels of NDFe recommended for high-energy diets vary between 5% and 8%. These values ensure that the rumen pH is maintained above the critical level of 5.7 without a drastic reduction in consumption (NRC, 2000). The roughage of finishing feeds can be replaced by WCG, which promotes a slower rate of starch availability for ruminal digestion than processed corn (TURGEON et al., 2010).

WCG may regulate starch fermentation and reduce the accumulation of acids in the rumen, mitigating digestive disorders. Katsuki (2009) calculated an NDFe value of 7.7% for the feed of young bulls in feedlots without roughage elements and with 85% of WCG. According to the author, and considering the NDFe theoretical concept, the NDFe was calculated considering 100% of NDF effectiveness in the WCG, which produces a sufficient stimulus for rumination and rumen motility, eliminating the need of long fiber contents in finishing feeds.

Brazil produces approximately 642 million tons of sugar cane in little more than 9 million hectares. From those, 280 million tons are destined to sugar production and 360 million tons to alcohol production (CONAB, 2014). Sugar cane bagasse, derived from the juice extraction performed by the sugar-alcohol industry, is the greatest residue produced by the Brazilian agroindustry. Each ton of processed sugar cane generates an average of 280 kg of bagasse that is used as fuel for boilers, cellulose production and cattle feeding (ALCARDE, 2009).

The bagasse is dried and finely ground to form a pellet. Pelletizing reduces the particle size and increases forage density, compromising the food function that involves buffering the rumen pH. Even when there is a high NDF content, the pellet disintegrates into miniscule particles within the rumen, providing the food with insignificant quantities of NDFe. This reduces the chewing and rumination activity, increasing the risk of acidosis (SALINAS-CHAVIRA et al., 2013).

Sugar cane bagasse pellets have been used as fuel for boilers. As they are easy to manipulate, occupy low storage space, can be smoothly transported given the high volumetric density, and do not show signs of aerobic decomposition, it may also be interesting to use them for feedlots. Not much is know about the use of sugar cane bagasse pellets in the diets of feedlots. Even with low NDFe, a high NDF content may help to maintain the rumen healthy, resulting in both productive and economical profits.

This study aimed to evaluate the productive and economical performance of finishing steers (in feedlots) fed with diets containing different levels of sugar cane bagasse pellets devoid of long fiber contents.

Materials and Methods

This work was performed at the Animal Production Center (NUPRAN) of the Midwestern State University (UNICENTRO), in Guarapuava, Paraná, Brazil. The region has a Cfb climate (subtropical mesothermal humid), with an average annual precipitation of 1.944 mm, average annual minimum and maximum temperatures of 12.7 °C and 23.5 °C, respectively, and relative air humidity of 77.9%, at an altitude of 1.026 m. The experiment started on 30 August 2011 and ended on 04 December 2011.

Three levels of sugar cane bagasse pellets (SBP) were tested in the diets (lacking forage with long fiber - 100% concentrated) of steers in feedlots, at the finishing stage. Level zero consisted in a diet composed of 80% of whole corn grains and 20% of a mix of protein, vitamin and mineral (pelleted). The other treatments consisted of similar food components, to which 7% or 14% of SBP were added. Supplementary urea was provided in order to have iso-nitrogenated diets, as shown in Table 1.

Table 1. Participation of the feeds used in the diet trials.

Composition of ingredients included on diet (% DM)	Levels of pellets		
	0%	7%	14%
Whole corn grains	79.83	74.22	69.14
Mix containing protein, vitamin and mineral	20.17	18.50	16.84
Sugar cane bagasse pellets	0.00	6.95	13.40
Additional urea	0.00	0.32	0.63

The following parameters were evaluated: daily dry matter intake (DMID, kg day^{-1}), dry matter intake in relation to body weight (DMIBW, % of body weigh), average daily weight gain (ADG, kg day^{-1}), feed conversion (FC), ingestive behavior, apparent digestibility of the diet, characteristics of integrating and non integrating elements of the animals' carcass, and economy of the treatment. The experiment lasted 100 days. The first 16 days were meant for adaptation, followed by four sequential evaluation periods of 21 days. The animals were weighed at the beginning and end of each period, after a 12-hour fast for solids.

Twenty-four steers from the Brangus breed were used. All animals came from the same herd, had an average age of 12 months and an initial body weight (BW) of 364 kg (standard deviation of 14 kg). The animals were distributed in a way that animal weight and body condition were equivalent between the experimental units. Twelve semi-covered 15 m^2 confining pens were used. Each had a concrete feeder and a metallic drinker regulated by a floater valve.

Because the animals were used to a feed consisting of pasture with concentrated supplementation of 1% BW, the adaptation to the final diet was performed in a progressive manner. Corn silage without restrictions plus 1.2% of BW of the final diet were provided from days 1 to 4. The final diet was supplemented in the proportions of 1.6% and 1.8% of the BW on days 5 and 9, respectively. Silage supply was interrupted on day 13, when the final diet was provided freely. The evaluations started after day 16.

Feed was provided two times per day, at 6 AM and 5 PM. The daily consumption was registered by calculating the difference in weight between feed provided and respective leftovers. The supply was adjusted daily aiming to offer *ad libitum* feed, and considering 10% of dry matter (DM) leftovers.

During the experiment, food, diet and leftover samples were collected and analyzed for contents of crude protein (CP), mineral matter (MM), ethereal extract (EE), neutral detergent fiber (NDF) with the α-amylase thermo stable enzyme and acid detergent fiber (ADF), according to methods described by Silva and Queiroz (2006). Total digestible nutrient content (TDN) was calculated according to the equations proposed by Weiss et al. (1992).

Table 2 shows the food analyses results. The protein, vitamin and mineral mix was fabricated with the following ingredients: soybean meal, soybean hulls, barley root, barley grains, corn grains, corn-germ, calcitic lime, dicalcium phosphate, cattle urea, common salt, vitamin and mineral premix and sodium monensin (80 mg kg^{-1}).

Table 2. Bromatological composition of feeds and experimental diets.

Feeds	Bromatological results (% of DM)[1]									
	DM	CP	TDN	EE	MM	ADF	NDF	NDFe	NDFfo	NDFefo
Whole corn grain	89.55	8.23	85.17	3.73	3.12	3.22	9.61	9.61[2]	-	-
Protein mix	90.58	36.4	61.76	2.34	5.35	8.14	14.36	-	-	-
Sugar cane bagasse pellets	93.70	1.93	42.66	1.81	5.21	70.96	84.70	17.87[3]	-	-
Urea	100.0	281.0[4]	-	-	-	-	-	-	-	-
Diets (pellets)										
0%	89.76	13.91	80.45	3.45	3.57	4.21	10.57	7.67	0.00	0.00
7%	90.06	13.88	77.61	3.33	3.67	8.83	15.68	8.38	5.89	1.24
14%	90.35	13.84	75.00	3.22	3.76	13.10	20.41	9.04	11.35	2.39

[1] Abbreviations: dry matter (DM), crude protein (CP), total digestible nutrients (TDN), ethereal extract (EE), mineral matter (MM), acid detergent fiber (ADF), neutral detergent fiber (NDF), effective NDF (NDFe), NDF from forage (NDFfo) and NDFe from forage (NDFefo).
[2] Calculated assuming 100% effectiveness of neutral detergent fiber (NRC, 2000).
[3] Calculated considering the proportion of particles retained on a sieve 1.18mm multiplied by neutral detergent fiber content, NDFe = [(21.1%*84.70)/100], according NRC (2000).
[4] Equivalent protein urea (45% N x 6.25 (correction factor) = 281.25.

Sodium monensin was added to the diets not only to improve performance, but also because the NRC (2000) recommends the use of ionophores in highly energetic diets with a NDFe content varying between 5% and 8% of DM, as an attempt to maintain the rumen pH above 5.7.

The ingestive behavior was evaluated on the fiftieth day after the experiment started. Observations were made during a continuous period of 72 hours. One observer per pen performed the measurements and registered the behavior activities every three minutes. The times spent in leisure, rumination, drinking (water ingestion) and feeding were measured (hours per day). Frequency of feeding activities (number of times per day), drinking, urination and defecation, were also annotated.

Concomitantly, apparent digestibility of DM in the experimental diets was evaluated. The whole production of feces for each experimental unit was collected, weighed and sampled in each of the 6 hours shift. After 72 hours of collection, the feces were homogenized to form a composite sample for dehydration, which allowed determining the apparent digestibility (AD) using the expression: AD (%) = [(g of consumed DM - g of excreted DM) ÷ g of consumed DM] x 100. This formula used the DMID from the same days of excreta collection, as the animals consumed the experimental feeds for fifty consecutive days.

At the end of the confinement period, and after the 12-hour fast for solids, the animals were weighed upon fridge loading (which was located at a 5 km distance). Normal slaughterhouse proceedings were used, in agreement with the legislation for bovine slaughtering.

Four development measurements were performed in the warm carcasses: carcass and arm lengths, arm perimeter and topside thickness, following the methods proposed by Muller (1987). The subcutaneous fat thickness was measured at the level of the 12th rib and the non-integrating elements of the animals' carcass were weighed.

Carcass gain, carcass yield and carcass feed conversion were calculated considering 50% of carcass yield at the beginning of the experiment. The economic analysis considered the average regional prices from 2014: fat cattle at R$ 8.02 per kg, corn at R$ 23.87 per 60 kg sac, protein mix at R$ 1218.42 per ton, SBP at R$ 238.70 per ton and cattle urea at R$ 74.44 per 25 kg sac.

A random experimental design was used, composed of three treatments with four repetitions. Each repetition consisted of a pen with two animals. The variables were submitted to variance analysis and the averages were compared by Tukey's test, using a 5% significance threshold. In addition, the performance variables were submitted to a polynomial regression analysis, where the four periods of 21 days were considered (total of 84 days). The data were analyzed using the statistical program SAS (1993).

This research project was approved by the ethics committee for animal use from the Midwestern State University (CEUA/UNICENTRO, protocol 028/2011).

Results and Discussion

Analysis of animal performance (Table 3) did not reveal interaction ($p>0.05$) between the treatments and the confinement periods for DMID, DMIBW and FC. DMID increased linearly, while DMIBW decreased linearly throughout the days in confinement. FC worsened linearly over the periods.

An interaction ($p=0.031$) between treatments and periods was detected for ADG. Seven percent of SBP in the feed produced a quadratic positive effect on ADG, while 14% of SBP promoted a linear decrease as the confinement days progressed. The ADG regression equation was not significant for 0% of SBP (Table 3).

On average, the 0% SBP diet had lower DMID ($p<0.001$), DMIBW ($p<0.001$) and ADG ($p=0.048$) than diets containing SBP. There was no difference in FC ($p=0.32$) between treatments.

Table 3. Performance of feedlot steers, fed diets devoid of long fiber containing levels of introduction of sugar cane bagasse pellets.

Pellets levels	Evaluation periods (days)				Average
	1º (1-21 days)	2º (22-42 days)	3º(43-63 days)	4º (64-84 days)	
	Dry matter intake daily (DMID, kg day^{-1}) [1]				
0%	7.89	8.08	8.65	9.11	8.43 b
7%	8.25	9.54	9.68	9.91	9.35 a
14%	9.27	9.25	9.72	10.01	9.56 a
	Dry matter intake (DMIBW, % by BW) [2]				
0%	2.02	1.92	1.92	1.89	1.94 b
7%	2.11	2.23	2.08	1.99	2.10 a
14%	2.35	2.16	2.11	2.04	2.17 a
	Feed conversion (FC, kg kg^{-1}) [3]				
0%	4.93	6.91	5.33	7.25	6.11 a
7%	5.06	5.35	5.71	7.85	5.99 a
14%	5.24	6.74	6.15	7.97	6.52 a
	Average daily weight gain (ADG, kg dia^{-1})				
0%[4]	1.611	1.190	1.667	1.270	1.434 b
7%[5]	1.635	1.857	1.698	1.278	1.617 a
14%[6]	1.794	1.397	1.603	1.357	1.538 a

Means in column, followed by different lowercase letters, differ by 5% Tukey test.
Regression equations for periods ("d"= day 1 to 84) : [1] $y=8.11+0.0191d$ ($p<0.001$; $R^2=0.29$; CV=7.9); [2] $y=2.22-0.0029d$ ($p=0.004$; $R^2=0.17$; CV=7.5); [3] $y=4.398+0.0345d$ ($p<0.001$; $R^2=0.35$; CV=18.5); [4]no significant ($p=0.3839$); [5] $y=1.122+0.032d-0.0004d^2$ ($p=0.004$; $R^2=0.55$; CV=12.9); [6] $y=1.814-0.0053d$ ($p=0.092$; $R^2=0.20$; CV=17.8).

Marques et al. (2011) tested the introduction of several levels of sugar cane bagasse (long fiber) in diets containing WCG for young Nelore bulls. Increasing the bagasse levels had a quadratic effect on DMID and a linear effect on ADG. DMID was 8.42 *vs* 10.51 *vs* 10.16 kg day^{-1} for 0% (diet without forage), 3% and 6% of bagasse, respectively. ADG was 1.197 *vs* 1.587 *vs* 1.555 kg day^{-1}, for the respective levels. There was no difference in FC, which had an average value of 6.730 kg kg^{-1}.

Katsuki (2009) evaluated the introduction of several levels of soybean hulls (0%, 15%, 30% and 45%) in diets containing WCG without forage. He found that there was a quadratic effect on DMID, showing the following values: 6.99, 8.34, 9.63 and 9.25 kg day^{-1}, respectively. Even though there were no differences for ADG and FC, the variation between treatments was noteworthy. ADG showed the following values: 0.953, 1.278, 1.440 and 1.227 kg day^{-1}, and FC was 8.012, 6.740, 6.852 and 8.552 kg kg^{-1}, for the respective levels.

Both these studies were performed in animals of the Nelore breed and reported a lower ADG than the present study. This suggests that zebu cattle are less susceptibility to diets without forage (low NDF and/or pectin) than taurine or cross cattle. This includes WCG treatments without roughage, as reported by Marques et al. (2011), treatments without sugar cane bagasse, as reported by Katsuki (2009), and treatments without soybean hulls. Ueno (2012) showed that animals from the Canchim breed that were fed diets without forage with WCG had performances similar to those reported in this study, with an ADG of 1.564 kg day^{-1} and a FC of 4.57 kg kg^{-1}.

The estimated TDN levels on the experimental diets (Table 2) and the lower DMID observed in animals treated with 0% of SBP suggest that the energetic density of this feed had a regulatory effect on animal DMID.

Krehbiel et al. (2006) computed data from 45 assays to assess the effects of increasing the energetic density in finishing diets. According to the authors, increasing the proportion of grains causes a reduction in DMID, a response that has been consistently described in the literature. Several hypotheses may explain this effect, but it seems that the mechanisms of chemotactic regulation or the potential increase in acid metabolites are what determine this consumption response. The increase of energetic density on the diet has an inversely proportional effect on DMID. On the other hand, the regression between consumption of metabolizable energy (ME) and energetic density on the diet is not significant, showing that finishing bovines consume DM to maintain a constant ME intake.

However, the same authors state that there is a cubic effect when ME consumption is evaluated in function of the increase in dietetic ME derived from grains. Animals that are fed low forage levels have a slightly higher ME consumption than those fed with completely concentrated diets, in agreement with the ME consumption data of this study (Table 4).

The linear decrease in DMIBW, observed over the confinement period, may indicate that animals adapt better to this chemotactic mechanism of regulation of feed consumption over time.

Table 4. Average feed consumption and neutral detergent fiber (NDF) for feedlot steers, fed diets devoid of long fiber containing levels of introduction of sugar cane bagasse pellets.

Feed intake (kg of DM day^{-1})	Pellets levels		
	0%	7%	14%
Whole corn grain	6.73	6.94	6.61
Protein mix	1.70	1.73	1.61
Sugar cane bagasse pellets	0.00	0.65	1.28
Adittional urea	0.00	0.03	0.06
Metabolizable energy intake (Mcal day^{-1})[1]	24.53	26.18	25.91
NDF intake (% of average BW)	0.20	0.33	0.44
NDFfo intake (% of average BW)	0.00	0.12	0.25

[1] Calculated by equation based on total digestible nutrient content of the diet (NRC, 2000).

Turgeon et al. (2010) infer that the DMIBW for finishing diets with little or no roughage is well predicted by the following equation: 1.906 + 0.0199*NDFfo (NDF from forage). Using the data from Table 2, the DMIBW values estimated by this equation are 1.91%, 2.02% and 2.13% for feeds with 0%, 7% and 14% of SBP, respectively, which is very similar to the averages observed in this study (see Table 3).

The consumption of metabolizable energy was similar to that described by Katsuki (2009), who reported 21.23, 23.78, 25.68 and 24.10 Mcal day^{-1} for diets without forage, with WCG and 0%, 15%, 30% and 45% of soybean hulls (although the effect was not significant). NDF consumption by the BW showed an increasing linear effect, with values of 0.14, 0.29, 0.49 and 0.67, respectively. Both consumption of NDF and consumption of NDF derived exclusively from forage increased linearly (Table 4).

Table 5 shows that the diet with 14% of SBP had a lower apparent digestibility of DM. The introduction of SBP tended to increase manure production (p=0.076) and rumination time (p=0.072).

Katsuki (2009) found that the introduction of soybean (0%, 15%, 30% e 45%) caused a linear decrease in feed digestibility (84.18%, 78.58%, 65.42% and 69.23%, respectively). Marques et al. (2011) reported that introducing 0%, 3% or 6% of sugar cane bagasse increased linearly the starch digestibility (respectively: 72.74%, 74.27% and 79.45%).

Table 5. Apparent digestibility and feeding behavior of feedlot steers, fed diets devoid of long fiber containing levels of introduction of sugar cane bagasse pellets.

Evaluation	Pellets levels			Prob.
	0%	7%	14%	
Apparent digestibility of DM (%)	74.78 a	74.48 a	69.05 b	0.008
Manure production (kg of DM per animal day^{-1})	2.05	2.47	2.70	0.076
Behavioral activities (hours day^{-1})				
- Rumination time (hours day^{-1})	1.58	1.95	2.18	0.072
- Leisure time (hours day^{-1})	20.07	19.91	19.37	0.146
- Feeding time (hours day^{-1})	2.11	1.96	2.27	0.266
- Drinking time (hours day^{-1})	0.24	0.20	0.17	0.377
Behavioral activities (number of times per day^{-1})				
- Feed	16.56	13.78	16.11	0.073
- Drinking	6.89	7.00	6.78	0.981
- Urination	10.22 a	7.89 ab	6.44 b	0.030
- Defecation	6.89 b	8.67 a	7.56 ab	0.036

Means in line, followed by different lowercase letters, differ by 5% Tukey test.

Ueno (2012) found that finishing bovines fed with a WCG diet without forage exhibited periods of rumination of 1.28 hours day^{-1}. Feeds with 45% corn silage promoted rumination periods of 7.17 hours day^{-1}.

Salinas-Chavira et al. (2013) evaluated the effect of pelletized or chopped rice straw (at 5 or 10% of the DM) in finishing diets. Ruminal pH was 5.2 and 5.7 for diets with pelletized and chopped straw, respectively. According to the authors, pelletizing increases the particle density, reducing total chewing activity, rumination time, and consequently ruminal pH.

Animals fed with 0% of SBP had a greater frequency of daily urination, possibly due to higher daily consumption of water. Blood et al. (2002) states that bovines with sub-acute ruminal acidosis may ingest large quantities of water, especially after ingesting dry grains. This may occur due to the rise in concentration of ruminal lactic acid, which in turn increases the osmolarity and withdraws water from the circulating system, causing hemo-concentration and dehydration.

The evaluation of the animals' carcass (Table 6), did not find differences in carcass weight between treatments. Carcass yield improved marginally for animals consuming a diet with 0% of SBP, but this difference was not significant.

Table 6. Carcass characteristics of feedlot finished steers, fed diets devoid of long fiber containing levels of introduction of sugar cane bagasse pellets.

Variables	Pellets levels			Prob.
	0%	7%	14%	
Body weight ranch (kg)	505.2	517.0	517.3	0.275
Hot carcass weight (kg)	284.7	285.7	284.7	0.975
Carcass yield (%)	56.3	55.2	55.0	0.320
Fat thickness (mm)	3.83 b	6.33 a	4.33 b	0.009
Carcass length (cm)	148.8	150.0	151.5	0.475
Thigh thickness (cm)	23.5	23.0	24.3	0.316
Arm lenght (cm)	37.7	38.0	37.5	0.623
Arm perimeter (cm)	40.9	40.3	40.0	0.795

Means in line, followed by different lowercase letters, differ by 5% Tukey test.

Thickness of the subcutaneous fat layer was greater for animals treated with a diet containing 7% of SBP. According to Krehbiel et al. (2006), this may be due to the greater ADG rates and ME consumption observed in this treatment (Table 4).

Work by Marques et al. (2011) showed that supplying 0%, 3% or 6% of sugar cane bagasse neither altered the carcass yield (57.66%) nor the thickness of the subcutaneous fat layer (4.85 mm). Nevertheless, there was a linear increase in the weight of the warm carcass, with values of 273.91 *vs* 290.17 *vs* 293.85 kg for the respective levels.

Analysis of non-integrating elements of the animals' carcass (Table 7) showed differences only for the tongue ($p<0.05$). Animals fed with 0% of SBP had heavier tongues than those treated with 14% of SBP, possibly because diets with 0% of SBP have a lower volume, creating greater difficulties for food capture and demanding, therefore, greater utilization (exercise) of the tongue for ingestion, salivation and swallowing.

As described in Table 8, no differences were detected in animal carcass gain between treatments ($p>0.05$). However, the diet with 0% of SBP showed a tendency to produce greater ($p=0.16$) yields in carcass gain (% of ADG expressed in carcass) and a better ($p=0.09$) conversion of feed into carcass, compared to the diets with SBP.

The introduction of soybean hulls (0%, 15%, 30% and 45%) in diets without forage with WCG did not influence carcass characteristics (KATSUKI, 2009). Average carcass weight was 297 kg, average carcass yield was 55.18% and average fat thickness was 6.58 mm. There was no effect on yield of carcass gain, which had the respective values of 85.40%, 85.86%, 76.09% and 75.35%.

Table 7. Non-integrating components of carcass of feedlot finishing steers, fed diets devoid of long fiber containing levels of introduction of sugar cane bagasse pellets.

Variables (kg)	Pellets levels			Prob.
	0%	7%	14%	
Head weight	11.22	11.75	11.54	0.387
Tongue weight	0.96 a	0.92 ab	0.87 b	0.042
Tail weight	1.34	1.43	1.30	0.184
Heart weight	1.56	1.70	1.71	0.072
Liver weight	6.02	6.04	6.31	0.312
Kidneys weight	0.99	1.04	1.00	0.387
Lung weight	6.87	7.36	7.11	0.222
Spleen weight	1.92	1.82	1.85	0.724
Full rumen-reticulum weight	39.13	36.55	38.43	0.634
Empty rumen-reticulum weight	10.06	10.56	10.80	0.610
Full abomasum weight	2.86	3.80	3.38	0.140
Empty abomasum weight	2.14	2.58	2.63	0.343
Full intestine weight	18.17	21.40	20.41	0.157
Paws weight	10.3	10.7	10.5	0.495
Leather weight	43.9	41.8	43.1	0.290
Testicles weight	1.18	1.47	1.29	0.113

Means in line, followed by different lowercase letters, differ by 5% Tukey test.

Turgeon et al. (2010) performed 6 experiments comparing traditional finishing diets (with 4% to 10% of forage in the DM) with diets without forage with WCG (from 8% to 23% of WCG in the DM). Five of their assays showed that animals fed with forage suffer increases of 1.5% in their final weight, 3.7% in ADG and 5.7% in DMID, and have greater carcass gains. These assays also showed that the benefit of using diets without roughage is that they provide improvements in FC (3.5%) and in FC in the carcass (7.662 *vs* 7.881 kg kg^{-1}), corroborating the data of this study. This study shows that the use of completely concentrated diets is an interesting alternative for producers who commercialize animals based on the carcass weight rather than on BW.

Table 8. Carcass gain and economic analysis of feedlot finishing steers, fed diets devoid of long fiber containing levels of introduction of sugar cane bagasse pellets.

Variables	Pellets levels			Prob.
	0%	7%	14%	
Feedlot carcass gain (kg)	97,45	98,15	96,78	0,969
Carcass gain yield (%)	74,68	69,31	68,43	0,159
Average daily carcass gain (kg)	1,068	1,120	1,051	0,479
Feed conversion in carcass (kg)	7,893	8,381	9,145	0,095
Daily cost feed (R$)	5,28	5,66	5,61	0,202
Feed feedlot cost (R$)	443,37	475,49	471,07	0,202
Revenue of the carcass gain on feedlot (R$)	781,48	787,10	776,14	0,969
Profit margin (R$)	338,11	311,61	305,06	0,719

Introducing SBP in the feed reduced the cost per kg of diet. The observed values were 0.63 *vs* 0.61 *vs* 0.59 R$ per kg of DM for 0%, 7% and 14% of SBP, respectively. However, due to variations in DMID, the supply of 7% or 14% of SBP tended to promote greater (p=0.20) daily costs of feeding, compared to the diet with 0% of SBP (Table 8).

The resemblance between gain in carcass weight for different treatments (Table 8) provided similar revenues for animal fattening. However, diets containing SBP showed a tendency for greater feeding costs. Thus, the diet with 0% of SBP had the better profit margins (p=0.72), when deducting feeding costs.

Conclusions

The introduction of sugar cane bagasse pellets in diets devoid of long fiber contents for steers in finishing stages in feedlots increased feed consumption, gain in body weight and thickness of the subcutaneous fat layer. In addition, it tended to increase the rumination time and the daily cost of feeding. The better productive performance of animals fed 7% of pellets did not translate into a greater carcass weight.

Therefore, the introduction of sugar cane bagasse pellets in a diet devoid of long fiber improved the productive performance but not the economic results of steers finished in feedlots.

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