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Soy deactivated in semi feedlot diets for heifers 1/2 angus-Nellore

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ABSTRACT. This research evaluated the effects of diets containing or not containing deactivated soybean sums on productive performance, carcass attributes, carcass ultrasound, and feed cost in confined heifers with 1/2 Nellore-Angus blood. We used blood from 60 1/2 Nellore-Angus heifers aged 2 or 25 years with a body weight of 404.62 kg. A completely randomized design was used, in which the animals were divided into 2 experimental groups: Cont (concentrated for semi feedlot without added deactivated soybean) and Bocchi (concentrated for semi feedlot with the addition of deactivated soybeans). There was no significant difference in the final weight between the experimental groups or for the consumption of concentrate in the evaluation periods. However, heifers supplemented with deactivated soybean in the diet showed greater daily weight gain than did those in the Cont group, as well as greater carcass weight, arrobas gain, and carcass yield. Bocchi concentrate was less expensive than Cont (U$ 7.26 ton^{-1}). The addition of deactivated soybean for finishing cattle is indicated because it provided the animals with higher energy intake and positively influenced the productive performance as a final weight gain greater than that of the feed without adding the deactivated soybean in addition to lower production cost.

Keywords: beef cattle; performance; protein; soybean; supplementation.

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Introduction

In beef cattle farming, pasture-based production suffers the effect of the nutritional value of grasses throughout the year, which often cannot meet the protein and energy requirements of animals in their different productive phases. Given low nutrient levels, it is necessary to supplement animals in grazing systems in tropical regions when the nutrient balance is not met by forage.

In systems that seek intensification, supplementation becomes an ally to increase productivity per area, in addition to enabling the exploration of the genetic potential of animals, which maintains constant production throughout the year according to the bromatological quality of forage plants, maximizing the productive and economic performance of production systems (Giacomel et al., 2022). Among the various foods that can be used in the formulation of supplements for cattle, deactivated soy appears to be an interesting alternative because it has high biological value and is a lower-cost byproduct than traditional soybean meal.

Deactivated soybeans, or roasted soybeans, result from the thermal processing of soybeans at high temperatures. This process has the benefit of deactivating antinutritional factors such as protease inhibitors, lectins, and allergens, which are inactivated by heat (Rocha et al., 2014). Soy has a high nutrient content, with values close to 40 crude protein and 20% ether extract, making it an excellent source of protein and energy (Chiodi, Luz, & Oliveira, 2022).

In animals finishing on pasture, the provision of supplements maximizes gains, both due to the nutrients provided and the improvement in the digestibility of pasture fiber, since supplements provide nitrogen for microbial synthesis.

In their composition, deactivated soybeans are in the RDP fraction, which is the main source of nitrogen for maximizing the multiplication of ruminal microorganisms, in addition to the high amount of energy coming from the oil, which favors weight gain and carcass finishing of the animals (Oliveira et al., 2015; Cônsolo et al., 2015).

Therefore, this research aimed to evaluate the performance, carcass yield, and production cost of supplemented finishing beef heifers receiving a supplement with deactivated soybeans.

Materials and methods

Location, animals, and diets

The experiment was conducted at Fazenda Nossa Senhora do Abadia, located in the municipality of Douradina, MS. The project was submitted, analyzed, and approved by the research ethics committee of the Federal University of Grande Dourados, under number 33/2020. Sixty F1 ½ Angus-Nelore blood heifers aged 2.25 ±0.85 years and with a body weight of 404.62 ±13.45 kg were used.

The experimental design adopted was completely randomized, in plots divided over time, where the animals were divided into 2 experimental groups: 1- Cont, concentrated for semi feedlot without the addition of deactivated soybeans; 2- Bochi concentrate for semi feedlot with the addition of deactivated soybeans. Both concentrates were formulated with the same crude protein content (16%), differing only in the content of total digestible nutrients (TDN). The diets were balanced using BCNRM software to achieve weight gains between 800 and 1000 g day^{-1} (Table 1).

The experimental period lasted 90 days, and the animals were evaluated every 30 days. The concentrate was supplied twice a day, always at 6:00 am and 1:00 pm. The quantity supplied corresponded to 1% of the live weight, adjusted daily according to the surplus of each batch individually.

Table 1. Composition and nutritional value of the experimental diets used.

Ingredient	Control	Bochi
Inclusion, %		
Ground corn	77.7	77.7
Soybean meal	15.0	-
Deactivated soy	-	15
Urea	1.3	1.15
White salt	1.0	1.0
Mineral nucleus	5.0	5.0
Nutricional Composition (g kg^{-1} DM)		
DM	890.6	892.2
TDN	694.7	721.5
CP	160.0	160.0
EE	31.4	52.4

DM: Dry matter; TDN: Total digestible nutrients; CP: Crude protein; EE: Ethereal extract.

Pasture management

The 2 experimental groups were maintained on 2 *Brachiaria brizantha (Hochst.) paddocks. Stapf*. CV. Marandu of 8.2 ha, where every 30 days of rotation was carried out between groups to remove the effect of paddock and pasture from the results obtained.

These paddocks came from crop-livestock integration, where in previous years, the area was intended for cultivation in a succession of soybeans and corn, and in the year of the experiment, soybeans were cultivated; subsequently, the formation of the pasture, after 90 days of pasture implementation, was characterized by uniform grazing, and when they reached 40 cm in height, experimental grazing began. At the beginning of the study, the pasture areas had 3,230 kg of DM ha^{-1}, 12.34% crude protein, and 68.56% neutral detergent fiber (NDF).

Productive performance

To measure productive performance every 30 days, the animals were weighed after a 12 hour fast, and the weight gain per period and the average weight gain over the 90 days of study were calculated. The feed conversion (FC) was calculated as the total dry matter (DM) of the concentrate ingested during the experiment divided by the total empty body weight gain (WGvz), with the forage consumption not being computed.

Carcass ultrasound

At 60 days of the experimental period, during weight control, in vivo ultrasound measurements were carried out using an Aloka ultrasonic device (model SSD 500 Micrus; Aloka Co. Ltd.) with the aid of a 3.5 linear transducer. MHz and 172 mm long.

Subcutaneous fat thickness (SFT mm) and rib eye area (REA cm^2) were measured. In addition, the SFTs 100 kg^{-1} of live weight and carcass and the REA 100 kg^{-1} of live weight and carcass were calculated, providing better observations of carcass finishing and performance.

Carcass weight and yield

The animals were weighed after a 12 hour solid fast and slaughtered following the rules of the Ministry of Agriculture, Livestock and Supply (Brasil, 2004). After slaughter, the carcasses were divided into two halves, weighed to obtain the hot carcass weight (HCW), identified, and sent to the cooling chamber for 24 hours at a temperature of 0°C. Carcass yield was calculated according to the final weight of the animals after 90 days of semi feedlot and the carcass weight provided by the slaughterhouse.

Food costs

To determine the costs of feeding the animals, the prices of protein cores and cornmeal used in the composition of the concentrate were considered. The cost of the protein core of the Cont group was obtained through consultation with the market in the Douradina-MS region. The cost of the protein core with the addition of deactivated soybeans was obtained from Rações Bocchi LTDA. The price of corn was obtained through the Centro de Estudos Avançados em Economia Aplicada-Cepea USP website for the southern region of Mato Grosso do Sul in August 2019, when the trial began. The cost of pasture per animal was obtained through Anualpec (IEG/FNP, 2018). After price formation, the values were converted to dollars according to the Ibovespa quotations for the year 2019.

Statistical analyses

The data obtained were subjected to the normality of residuals and homogeneity of variances by Proc Univariate.

Data on weight gain, concentrate consumption, and feed conversion were analyzed by Proc Mixed according to the following model:

$$Y_{ijk} = \mu + A_i + D_j + T_k + D_j{*}T_k + e_{ijk}$$

where:
Y_{ijyk} = dependent variable,
μ = overall average,
A_i = animal effect ($_j$ = 1 a 60),
Dj = diet effect ($_y$ = 1 a 2),
T_k = effect of time ($_k$ =1 a 3),
$D_j{*}T_k$ = diet and time interaction effect, and,
e_{ijkl} = error. The random effect of the model (Random) was characterized by the following: A_i. The degrees of freedom were corrected by DDFM= kr.

Ultrasound data and carcass attributes were analyzed by Proc Mixed according to the following model:

$$Y_{ij} = \mu + A_i + D_j + e_{ij}$$

where:
Y_{ijyk} = dependent variable,
μ = general average,
A_i = animal effect ($_j$ = 1 to 60),
Dj = diet effect (y = 1 to 2), and,
e_{ijkl} = error.

The random effect of the model (Random) was characterized by the following: Ai. The degrees of freedom were corrected by DDFM= kr. The data obtained were subjected to analysis of variance using the Proc Mixed command of SAS, version 9.0 (Statistical Analytical Systems [SAS], 2012), adopting a significance level of 5% and the t test to evaluate the treatment means.

Results

Productive performance

No difference (P > 0.05) in final weight was detected between the experimental groups (Table 2).

Table 2. Productive performance of ½ blood Nelore-Angus heifers according to the experimental diets.

Item	Experimental diets[1] kg		EPM[2]	P value		
	Cont	SOY		Diet	Time	Interaction
Initial weight, kg	412.15	397.08	4.452	-	-	-
Final weight, kg	473.30	475.22	3.986	0.763	0.001	0.043
Weight gain, kg day^{-1}	0.697	0.858	0.003	0.012	0.001	0.886
Conversion	5.96	5.18	1.331	0.045	0.022	0.679
Feed intake (kg day^{-1})						
	4.17	4.44	1.093	0.665	0.662	0.976

[1]Cont (semi feedlot concentrate 10% proteic nucleus + 90% cornmeal); Bocchi (semi feedlot concentrate 10% proteic nucleus with the addition of deactivated soy + 90% cornmeal),[2]EPM (mean standard error),[3]Probability of the effect of diet, time and interaction of time and diet.

Heifers supplemented with deactivated soybeans showed better feed conversion than did those in the Cont group (P < 0.05); however, no significant differences in concentrate consumption were observed between the experimental groups, as shown in Figure 1.

A significant difference in feed conversion was observed between treatments (P < 0.05). Heifers supplemented with deactivated soy in the concentrate achieved greater daily weight gain and better feed conversion than did the Cont group throughout the entire experimental period, as shown in the graph in Figure 2.

No significant difference was detected between the experimental groups (P > 0.05) for concentrate consumption in the evaluation periods presented below or for the average concentrate consumption, as illustrated in Figure 3.

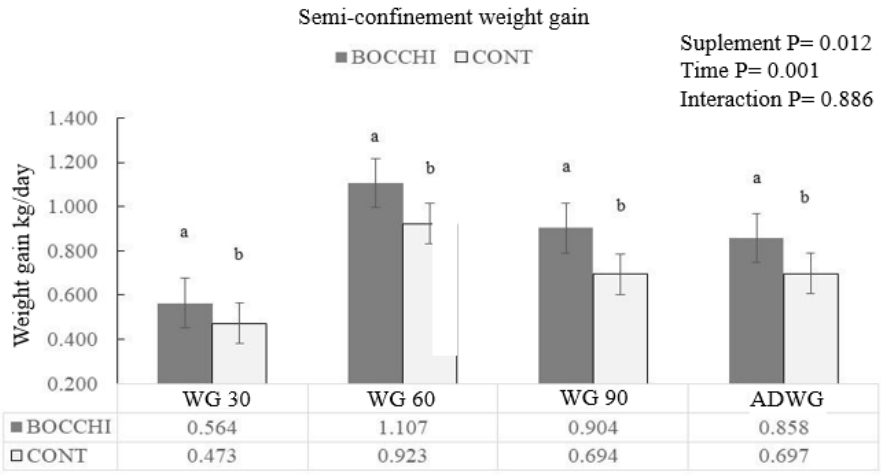

Figure 1. Graph of average daily weight gain according to the experimental diets as a function of the experimental period. Cont, semi feedlot concentrate 10% proteic nucleus + 90% cornmeal; Bocchi, semi feedlot concentrate 10% proteic nucleus with the addition of deactivated soy + 90% cornmeal; WG, weight gain; ADWG, average daily weight gain.

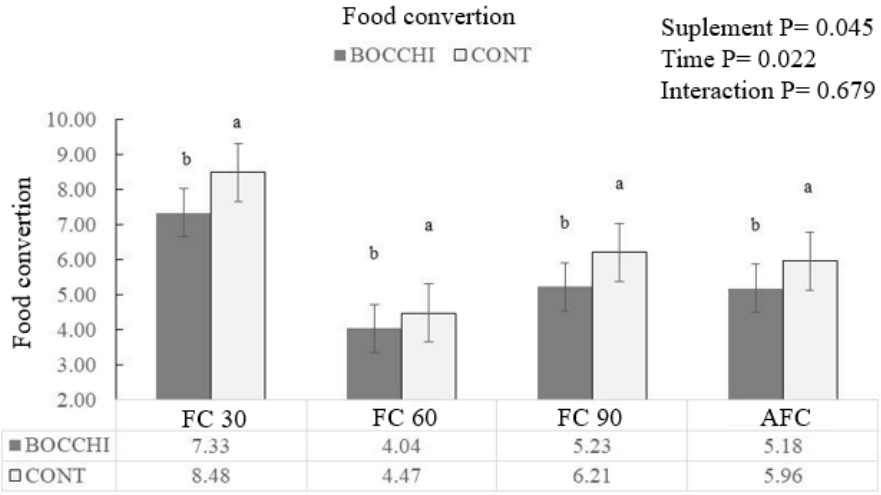

Figure 2. Food conversion chart according to the experimental diets depending on the experimental period. Cont, semi feedlot concentrate 10% proteic nucleus + 90% cornmeal; Bocchi, semi feedlot concentrate 10% proteic nucleus with the addition of deactivated soy + 90% cornmeal; FC, food conversion; AFC, average of food conversion.

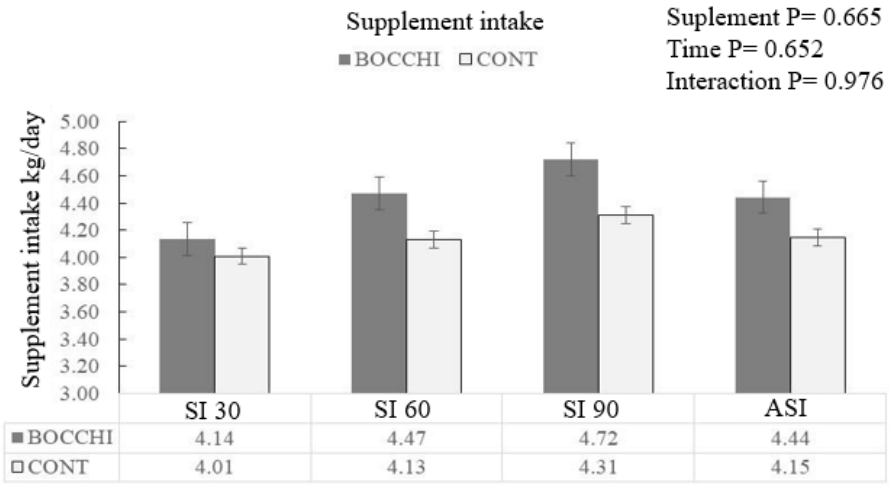

Figure 3. Graph of concentrate consumption according to the experimental diets according to the experimental period. Cont (semi feedlot concentrate 10% proteic nucleus + 90% cornmeal); Bocchi (semi feedlot concentrate 10% proteic nucleus with the addition of deactivated soy + 90% cornmeal); SI (supplement intake); ASI (average of supplement intake).

Carcass yield

There was a significant difference ($P < 0.05$) in the attributes of carcass yield, the control concentrates, and the Bochi ratio with the addition of deactivated soybeans, which presented greater average weight gain, arroba, subcutaneous fat thickness, and loin eye area (Table 3).

The results suggest that the 'Bocchi' diet, with the addition of deactivated soybeans, provided a higher carcass weight, a greater arroba value, and a greater carcass yield than the 'Cont' diet.

Food costs

The food costs are described in Table 4. The experimental treatment had a lower cost (in dollars) than the control diet.

Table 3. Carcass attributes and ultrasound according to the experimental diets.

Variable	Experimental Diets[1]		SEM[2]	P value[3]
	Cont	Bocchi		
Carcass				
Weight (kg)	248.25	251.80	1.738	0.044
Arroba (@)	16.55	16.78	0.115	0.044
Carcass yield (%)	52.29	53.09	0.128	0.001
Carcass ultrasound				
REA (cm^2)	43.33	46.13	0.536	0.007
SFT (mm)	6.53	6.89	0.096	0.066
Live weight ratio				
REA/100 (cm^2)	10.66	11.40	0.137	0.006
SFT/100 (mm)	1.61	1.69	0.020	0.052
Carcass weight ratio				
REA/100 (cm^2)	17.39	18.35	0.212	0.012
SFT/100 (mm)	2.61	2.76	0.042	0.059

[1]Cont, semi feedlot concentrate 10% protein nucleus + 90% cornmeal; Bocchi, semi feedlot concentrate 10% protein nucleus with addition of deactivated soy + 90% cornmeal; REA, rib eye area; SFT, subcutaneous fat thickness; [2]SEM, standard error of the mean; [3]Probability of diet effect.

Table 4. Food costs according to the experimental diets.

Item	Experimental diets	
	Cont	Bocchi
Food costs (U$)		
Concentrate (ton)	175.54	168.28
Concentrate (animal day^{-1})	1.00	0.74
Concentrate (animal $month^{-1}$)	30.14	22.22
Concentrate (animal 90 days)	90.43	66.75
Pasture (animal $month^{-1}$)	6.05	6.05
Pasture (animal 90 days)	18.15	18.15
TOTAL (animal 90 days)	108.59	84.91

In summary, the Bocchi diet resulted in lower food costs than did the Cont diet after 90 days. These costs can have significant implications for the economic viability of different diets and represent an important factor to be considered when evaluating the experiment.

Discussion

Productive performance

The daily weight gain of heifers supplemented with deactivated soy in the diet was greater than that of the Cont group. Supplementation with deactivated soy provided a 23.03% greater weight gain for heifers on the Bocchi diet than for those on the nonsupplemented diet. Likewise, heifers supplemented with deactivated soy showed better conversion than did those in the Cont group; however, no significant difference in concentrate consumption was observed between the experimental groups.

The increased performance of animals supplemented with deactivated soybeans can be attributed to the higher energy content of the Bochi concentrate compared to that of the control concentrate. This is explained by the high biological value of soy, which, when added to the diet, is better absorbed in animal metabolism. The oilseed soybean has a high energy value in its composition, coming mainly from the oil present in the grain, increasing its TDN content, which can reach 95% of TDN (Valadares Filho, 2006). In addition, after the deactivation process, there is an increase in the PNDR fraction of the grain, which can contribute to the metabolism, development, and performance of animals. In pasture finishing systems, the provision of an energy source combined with a protein source becomes an important tool for animal performance since grasses have low nutritional value that can negatively influence performance due to nutrient deficits (Detmann et al., 2005).

In grazing animals, performance is directly linked to the source of available nutrients, where maximizing gains depends on fiber digestibility. In the ruminal environment, the digestion of deactivated soybeans provides part of the nitrogen in the form of ammonia, and in the ruminal fluid, this material is used by cellulolytic bacteria for protein synthesis; in this respect, there is a maximization of microbial protein synthesis, increasing fiber degradation, and increasing DM intake by animals, in addition to the fact that deactivated soybeans provide a large amount of energy through the ethereal extract present in the grain, in addition to being an alternative ingredient to more expensive ones such as soybean meal (Oliveira et al., 2015; Cônsolo et al., 2015).

To evaluate the use of toasted soy in supplements for cattle finishing on pasture, Oliveira et al. 2015, evaluated the inclusion of toasted soy with inclusion values of 7, 14, 27.5, and 41% and a supply of 1.5 kg of concentrate animal^{-1} day^{-1}. The authors observed that the maximum animal performance was 1.1 kg day^{-1} and that there was no difference between the treatments. According to Stein et al. (2008), the use of soybeans is recommended for steers because it reduces the consumption of dry matter and allows the maintenance of consumption and energy in the diet without changing the pH of the rumen and ammonia nitrogen, ensuring the productive performance of the animals.

Attributes and carcass ultrasound

The better performance of the animals observed resulted in greater carcass weight, arroba gain, and animal yield when supplemented with a concentrate containing deactivated soybeans. The greater weight gain by the animals receiving the Bochi concentrate had a direct effect on the final weight of the carcass as well as the gain in the arrobas, where this group of animals had final weights 1.40 and 1.37% greater than those of the control treatment for weight in kg and the arrobas, respectively. In finishing animals, energy is mainly responsible for fat deposition and carcass finishing; thus, the ether extract content of deactivated soybeans increases the final TDN content of the concentrate compared to that of the control concentrate, favoring the performance of the animals.

For carcass yield, the inclusion of deactivated soybeans in the concentrate provided an increase of 1.20% compared to that of the control concentrate. Finishing animals on pasture with a supply of concentrates can maximize carcass yield since the supply of feed rich in nonfibrous carbohydrates increases the rate of passage of feed through the gastrointestinal tract, increases the deposition of muscle and fat in the carcass, and decreases the visceral proportion of body weight.

Similar results were observed by Menezes et al. (2014), who evaluated the carcass characteristics of heifers supplemented on pasture at levels of 0.5 to 1% of BW in concentrate and observed that animals with a higher level of supplementation had greater carcass yield (55.7%).

Regarding the use of soybeans in concentrates, Cônsolo et al. (2015), evaluating the inclusion of soybeans in the supplement of beef steers finishing on pasture at levels of 8, 16 and 24%, observed no difference in carcass characteristics between the inclusion levels evaluated. According to Restle et al. (2001), the variation in carcass yields in animals on pasture is due to differences in digestibility and the speed of passage of pasture through the digestive tract, as the content of the gastrointestinal tract is one of the determining factors of carcass yield.

Carcass ultrasound had the highest REA (cm^2), REA/100 (live weight), and REA/100 (carcass weight) for heifers supplemented with deactivated soybeans, a result that reinforces the higher carcass yield presented for this group of animals. The supplement with deactivated soybeans, as it contains greater energy, favored greater muscle development and fat deposition with carcass finishing in animals receiving greater energy, increasing REA. The highest REA is directly linked to factors such as the yield of meat cuts, carcass composition (muscle/bone ratio), degree of muscularity of the animal, growth, and weight gain, which increased with the supply of the concentrate with deactivated soybeans.

In work carried out by Cônsolo et al. (2017), the authors observed no effect of including soybeans in the diet of finishing cattle on REA cm^2, with average values of 64.7, 66.19, and 66.86 cm^2 for levels of 8, 16, and 24% of soybean inclusion in the diet, respectively; however, Menezes et al. (2014) highlighted that a higher concentrate content in the diet, and thus energy, can increase fat deposition and the conformation of the carcass finish.

Food costs

The cost of the Bocchi concentrate was lower than that of Cont (U$ 7.26 ton^{-1}). When the concentrate presented by each group was applied, a lower cost per animal day was observed for heifers supplemented with deactivated soybeans of U$ 0.74, monthly consumption of U$ 22.22, and at the end of the study of U$ 66. 75, a higher value of R$ 23.68.

As shown in Table 1, heifers in the Bocchi treatment group consumed more concentrate than did those in the other groups. Computing the fixed and equal costs for the 2 pasture groups, heifers supplemented with deactivated soybeans presented a total feed cost in the period lower than 27.88% compared to the Cont group.

Understanding all the factors that make up the intensive livestock production system and knowledge of the costs involved in all processes makes decision-making more reliable and provides producers with greater profitability (Alves et al., 2019). Thus, combining the animals' productive and economic indices, supplementing deactivated soybeans in the diet of ½ Nelore-Angus heifers in confinement proved to be a viable option for improving animal productivity.

Conclusion

The addition of deactivated soybeans for finishing cattle is recommended because it provides the animals with greater energy intake and positively influences production performance, such as increasing final weight gain compared with feed without the addition of deactivated soybeans, in addition to decreasing production costs.

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