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Economic Feasibility of Producing Feedlot Lambs Fed on Sunflower Cake

Research Article

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ABSTRACT

This study aimed to analyze the economic feasibility of replacing soybean meal by sunflower cake in the diet of lambs. Twenty-eight non-castrated crossbred Suffolk lambs aged four months, with 21 kg average body weight ± 9 kg were used. These animals were distributed by weight category into 3 treatments (10, 20 and 30% dry matter (DM) addition of sunflower cake in replacing soybean meal) and control (without addition of sunflower cake) in a randomized block design with seven replicates. After 84 days of trial, the animals were slaughtered. By the cost of each diet and consumption of animals, the economic feasibility was calculated. The treatment with 10% sunflower cake showed better economic indicators, based on the highest net revenue for marketing live or slaughtered animals. The inclusion up to 10% sunflower cake in the diet of feedlot lambs increases the economic viability of the activity.

KEY WORDS by-product, management, rural economy, sheep.

INTRODUCTION

Among the major factors that determine the profitability of a productive system, the costs of animal production are determinant for a successful economic activity (Oliveira *et al.* 2016a). In animal production, nutrition is one of the most relevant in sheep production systems, especially when the lambs are in feedlot, because in this system, the feed cost has great impact on the total cost of the activity (Lopes *et al.* 2011; Oliveira *et al.* 2016b).

Knowledge of production costs enables the bioeconomic analysis of the activity and through this, to clarify in detail the production factors such as land, capital and labor (Lopes and Magalhães, 2005).

To minimize costs with feed, mainly in feedlots, where the use of concentrate feed is high, it is interesting to use alternative ingredients, such as agro-industrial by-products that can reduce intake of noble foods (soybean meal) that have high acquisition value (Barroso *et al.* 2006; Monção *et al.* 2014; Monção *et al.* 2016). The increased supply of concentrate feed in the finishing phase has the purpose of increasing the energy density of the diet, which raises cost with feeding. Therefore, more research is needed with by-products as sunflower cake generated in the agro-industry with the potential to replace traditional ingredients such as soybean meal. Nevertheless, the sunflower cake has not been sufficiently studied considering their composition and the appropriate inclusion levels in diets for economic and

biological utilization in animal production, especially in goats and sheep (Cunha *et al.* 2008).

Oliveira *et al.* (2016b) mentioned that sunflower cake is a by-product of the processing of sunflower grain (*Helianthus annuus*), which is an annual dicot in the family composite that originated on the North American continent. Sunflower cake is used as an energy source for ruminants and is notable for its high lipid content (>35%) (Domingues *et al.* 2010; Goes *et al*. 2012). Additionally, sunflower cake is an alternative source of protein for ruminants, with a crude protein (CP) content of 23.50%, an average total digestible nutrient (TDN) content of 79.70% and a lipid content of 16.50%.

Based on the above, this study aimed to evaluate the economic feasibility of replacing soybean meal by sunflower cake in the diet of feedlot lambs.

MATERIALS AND METHODS

The procedures with the animals in this study were in accordance with the ethical principles of animal experimentation and approved in the Protocol 223/07 by the Ethics Committee for Animal Experimentation of the Federal University of Grande Dourados (UFGD).

The experiment was carried out at the facilities of Animal Science, Faculty of Agricultural Sciences, Federal University of Grande Dourados (UFGD), Dourados, Mato Grosso do Sul State. Twenty-eight non-castrated crossbred Suffolk lambs aged four (4) months, with 21 kg average weight ± 9 kg. These animals were distributed by weight category into 3 treatments (10, 20 and 30% DM addition of sunflower cake in replacing soybean meal) and control (without addition of sunflower cake) in a randomized block design with seven (7) replicates. The animals were blocked according to the experimental area and initial weight (covariate).

The experimental period lasted 84 days, preceded by 14 days to adapt to the management. The diets, and randomly assigned to 1.5 m^2 individual pens on 2 covered sheds, with curtains for temperature control, with mobile drinker and feeder and concrete floor covered with thick shavings, which was replaced daily. Animals were completely fasted for 12 hours before weighing every 14 days.

The diets were composed of forage, that was a proportional mixture of Tifton 85, Tifton-68 and Jiggs (*Cynodon* spp.) hays (33%), harvested at 35 regrowth days, and concentrate made up of ground corn, soybean meal and minerals (Table 1), formulated according to the NRC (2007) in order to meet the requirements of protein and energy for animals to gain 100 g/animal/day (Table 2). The 50:50 forage: concentrate ratio was used on a DM basis.

The contents of dry matter (DM), crude protein (CP), ether extract (EE) and mineral matter (MM) were determined according to the methodology proposed by AOAC (1995). The contents of neutral detergent fiber (NDF) and acid detergent fiber (ADF) according to Van Soest *et al.* (1991) and Cappelle *at al*. (2001).

Samples of ingredients and orts from each lamb were daily collected during the 6-d sampling period and composited into a single sample per lamb and period. The daily adjustment of diet intake was carried out regarding the orts from the feeders, considering 10% of supplied. The feeding was performed twice a day, at 8:00 and 14:00, water was provided *add libitom*.

At the end of the experiment, the animals were fasted from solids for 14 hours, weighed and then were slaughtered. Animals were slaughtered by stunning was carried out by stunning followed by bleeding for five minutes, by cutting the carotid and jugular veins. Carcasses were cleaned, gutted and taken to the cooling chamber, hanged by the tarsal-metatarsal joint, 17 cm spacing between carcasses, for 24 hours at 5 ˚C. After cooling they were weighed to obtain the cold carcass weight (CCW).

Data as for the selling price, of animals and the cost of ingredients used in the diets were collected through historical quotation of the Center for Advanced Studies in Applied Economics of ESALQ/USP (Cepea, 2016; 03/02/2016) and in the market of Dourados, Mato Grosso do Sul State. The prices of *Cynodon* hay were obtained from the quantification of the production processes, including the quantification of diesel spent to arrive to the property and the daily wage of two workers.

The methodology proposed by Oliveira *et al*. (2016a) and Gerassev *et al*. (2013) was applied for the financial economic analysis, by using financial ratios such as cost of hay and total cost of feeding, cost of acquisition of hay and ingredients that make up the concentrate. The total expenditure (TE), which enabled to identify if the activity is profitable by multiplying the amount paid per kilogram of diet provided to the animals and the period when the diet was supplied (84 days); cost per kg weight gain (ratio of total expenditure on food per diet and weight gain per diet in the finishing, in kilograms). The gross revenue (GR): multiplying the final live weight (FLW) by the value collected with the kilogram sold; net revenue (NR): difference between gross revenue (GR) and total food expenditure throughout the finishing period rate of return as a function of diet cost: ratio of net income (NI) and total food expenditure (TE). It indicates the return of capital to each monetary unit applied and profitability: the ratio between gross revenue and net revenue, multiplied by 100.

It indicates the percentage of gain obtained on the sales. All calculations were carried out on the natural matter basis. The capital invested in the purchase of the animals was $ 759.49.

Table 1 Chemical composition of the ingredients used in the diets, % dry matter basis

Ingredients	DM	CP	MM	NDF	ADF	EE
Cynodon hay	88.39	8.01	6.73	55.92	23.71	0.88
Sunflower cake	89.26	24.27	1.89	41.49	11.36	23.54
Soybean meal	86.31	51.70	7.69	20.74	9.72	6.92
Ground corn	89.21	9.74	5.56	13.94	5.43	1.59

DM: dry matter; CP: crude protein; MM: mineral matter; NDF: neutral detergent fiber and EE: ether extract.

Table 2 Percentage and chemical composition of the experimental diets

Item	Level of inclusion of sunflower cake				Price of kg[1]
Ingredients (% DM)	0%	10%	20%	30%	
Cynodon hay	50.00	50.00	50.00	50.00	$ 0.12
Sunflower cake	0.00	10.00	20.00	30.00	$ 0.11
Ground corn	29.65	22.71	15.77	8.83	$ 0.12
Soybean meal	19.41	16.37	13.33	10.29	$ 0.13
Mineral premix[2]	0.20	0.20	0.20	0.20	$ 0.38
Limestone	0.73	0.71	0.69	0.68	$ 0.05
Diet composition					
Dry matter (DM) %	87.24	87.26	88.37	88.77	-
Crude protein (CP) %	17.00	17.00	17.00	17.00	-
Ether extract (EE) %	1.27	3.43	5.63	7.18	-
Neutral detergent fiber (NDF) %	60.22	61.96	62.54	60.33	-
Acid detergent fiber (ADF) %	30.51	29.83	29.51	26.80	-
Ash %	6.63	7.01	6.50	6.72	-
Total digestible nutrient (TDN)[3] %	56.60	55.60	55.30	56.54	-

[1] Source: Cepea 2016 (03/02/2016) and personal data; 1$ (US dollar)= R$ 3.9565.
[2] Mineral mix for lambs: P: 72 g/kg; Ca: 111 g/kg; Na: 174 g/kg; Mg: 9 g/kg; S: 12 mg/kg; Zn: 7.200 mg/kg; Cu: 600 mg; Mn: 1.550 mg/kg; Fe: 4.42 mg/kg; Co: 50 mg/kg; I: 75 mg/kg; Se: 13.50 mg/kg and Flúor (máx): 720 mg/kg.
[3] TDN= 91.0246 – 0.571588 × NDF; (estimated by Cappelle *et al*. (2001)).

For the economic analysis we considered market prices for the ingredients of the diet, the purchase value of animals and values obtained on the sale of the lambs. With the cost of each diet and intake, it was calculated the economic outcome for each diet.

The data were subjected to analysis of variance and, when the "F" test was significant, the levels of inclusion of sunflower cake were submitted to regression analysis ($P<0.05$) through the procedure REG (SAS, 2000). The selection of the best-fit model (linear or quadratic) was based on the significance of the F in the analysis of variance for the regression data, the trend of the data and the coefficient of determination (R^2).

RESULTS AND DISCUSSION

The inclusion of sunflower cake in replacing soybean meal in the diet decreased ($P<0.05$) the dry matter intake (DMI) and average daily weight gain (ADG) of the lambs, however, there was no effect of the inclusion of this by-product on feed conversion (FC) of animals (mean 8.9 g DM/g weight gain; $P>0.05$; Table 3).

The DMI of the control diet was 24.37; 46.53 and 55.39% greater than the diets containing 10, 20 and 30% sunflower cake, respectively.

According to regression analysis, the DMI decreased linearly with increasing levels of sunflower cake, and for each percentage unit of sunflower cake added there was a reduction of 0.02% in the DMI. For the ADG, a linear decrease of 0.003% was detected for each percentage unit of sunflower cake added. Possibly due to the reduction in the DMI, the ADG of lambs fed sunflower cake was not satisfactory, as it were lower than recommended by the NRC (2007) for animals of this category, which varies between 100 and 170 g ADG.

Feed intake is a function of the animal that is directly related to body weight, level of production, body weight variation and to the physiological state, besides the type of food and feeding conditions (Van Soest, 1994).

In this study, the reduction in DMI with increasing inclusion of sunflower cake can be explained by the higher content of ether extract (23.54%) (Table 1), because in agreement with Palmquist and Mattos (2006), unsaturated fatty acids, as those found in plants, are toxic to rumen microorganisms.

Since the content of ether extract increased with increasing levels of sunflower cake in the diets, the reduced intake could be expected.

Bosa *et al*. (2012) observed a reduction in DMI of lambs fed coconut cake in the diet.

Table 3 Dry matter intake (DMI), average daily weight gain (ADG) and feed conversion (FC) of feedlot lambs fed diets containing different levels of sunflower cake in replacing soybean meal

Variables	Levels of sunflower cake (%)				
	0	10	20	30	CV* (%)
DMI (kg/day)[1]	1.038	0.785	0.555	0.463	11.750
ADG (kg/animal/day)[2]	0.118	0.083	0.056	0.028	15.090
FC (g DM/g weight gain)	8.1	8.4	8.3	10.7	24.9

[1] DMI: $\hat{Y}$= 1.00 – 0.02X; r^2= 0.96.
[2] ADG: $\hat{Y}$= 0.11 – 0.003X; r^2=0.99.
* CV: coefficient of variation; 1$ (US dollar)= R$ 3.95.

The authors emphasized that the lipid supplementation above 5% DM decreased the intake by regulatory mechanisms controlling feed intake or by the limited ability of ruminants to oxidize fatty acids. Supplementation with up to 8% of EE has been used successfully in diets for feedlot animal in places with high
temperature, where the intake of DM by animals is generally compromised. In such a situation, supplementation increases energy intake (Palmquist and Mattos, 2006).

Regarding the inclusion of sunflower cake, there was no significant difference differences (P>0.05) in FC compared to the control group with a mean of 8.9 g DM/g weight gain. Gerassev *et al.* (2013) evaluated the performance of feedlot Santa Ines lambs and found no effects on FC when included 20 and 40% of hay of banana leaf and pseudostem (by-products) in the diet, showing, on average, 7.9 g DM/g weight gain.

There was a reduction in the costs ($/animal/day) of concentrate, forage, total expenditure and cost of the total diet ($/kg) with the inclusion of sunflower cake in the diet (Table 4). The cost of kg body weight ($) ranged from $ 0.89 to 1.25/kg body weight for animals receiving 20% sunflower cake and for the control group, respectively.

Azevedo *et al.* (2012) evaluating the inclusion of 0% to 30% of macaúba cake in the diet of finishing lambs, observed a variation of $ 0.55-0.60/kg per body kilogram, values well below the results found in this study.

Although there was a reduction in the total feeding cost when used the by-product, the final slaughter body weight, cold carcass weight and gross revenue were lower in the animals receiving the cake. The control animals were slaughtered with 2.99, 6.96 and 8.58 kg heavier (body weight) than the animals that received 10, 20 and 30% sunflower cake in the diet, respectively (Table 5).

Despite the lower values of final body weight, cold carcass weight and gross revenue of animals supplemented with sunflower cake in relation to the control group, the animals receiving 10% sunflower cake in the diet showed higher net revenue relative to control animals, both in the sales of live (32.33 $/animal) or slaughtered (30.23 $/animal) animals.

Gerassev *et al.* (2013) observed higher net revenue, both in the sales of live and slaughtered animal, in animals fed 20% hay of banana leaf, which was $ 18.69 and 18.96/animal, respectively. These results are below those found in this research and may be related to the type of by-product and its value in the region. Diets containing sunflower cake showed positive indices and satisfactory rates of return compared to the control diet, indicating that the activity is covering its feeding costs, and it can be inferred a trend of financial gains, highlighting the treatments with greater level of inclusion in the diet (Table 6).

A significant profitability was verified in all treatments and in the control group, emphasizing an increased profitability in animals fed sunflower cake in the diet, because were the treatments that obtained higher net revenues (Table 6), and the profitability is a ratio between net revenue and gross revenue.

In this context, Barros *et al.* (2009) evaluated the profitability of Suffolk sheep production on pasture and in feedlot, and observed that the profitability ranged from -11.95% to 5.09%, respectively. In this research, the profitability of the lambs varied between 74.22% and 93.04%. Profitability depends on several factors, including the breed, with great variation in relation to sex, age and category and availability of the by-product.

Moreover, Vieira *et al.* (2012) investigated the profitability of feedlot lambs receiving detoxified castor bean cake (0, 50, 70 and 100% replacement of soybean meal) and found negative profits, even with selling price of $ 1.31/kg body weight. Possibly, the cost of the co-product was close to that of soybean meal, thus the replacement was not profitable in that condition.

In a global scenario, Brazil stands out as one of the main producers of soybeans (*Glycine max*), which when processed for the extraction of oil for human consumption generates the co-product soybean meal, widely used as a protein ingredient in animal feed and due to the high biological value of the protein.

The major purpose of replacing soybean meal with alternative sources such as sunflower pie is to reduce animal production costs.

Table 4 Feed costs of feedlot lambs receiving sunflower cake in replacing soybean meal

Variables	Levels of sunflower cake				
	0	10	20	30	CV (%)
Expense with concentrate ($/animal/day)	0.07	0.05	0.03	0.03	11.57
Expense with forage ($/animal/ day)	0.06	0.04	0.03	0.02	11.75
Cost of the complete diet ($/kg)	0.13	0.10	0.07	0.06	11.65
Total feeding cost ($/animal)	10.32	5.93	3.05	2.12	19.84
Cost of kg body weight ($)	1.25	1.01	0.89	1.13	28.43

CV: coefficient of variation.

Table 5 Final body weight, cold carcass weight, gross revenue and net revenue of feedlot lambs receiving different levels of sunflower cake in replacing soybean meal

Variables	Levels of sunflower cake				
	0	10	20	30	CV (%)
Final body weight (kg)	30.68	27.69	23.72	22.10	7.58
Cold carcass weight (kg)	13.19	11.90	10.20	9.50	7.58
Sale of slaughtered animals					
Gross revenue ($/animal)	40.07	36.17	30.99	28.07	7.58
Net revenue ($/animal)	29.74	30.23	27.93	26.74	8.50
Marketing of live animal					
Gross revenue ($/animal)	42.40	38.28	32.79	30.54	7.58
Net revenue ($/animal)	32.07	32.33	29.74	28.42	8.40

CV: coefficient of variation.

Table 6 Rate of return and profitability of feedlot lambs marketed alive and/or slaughtered

Variables	Levels of sunflower cake				
	0	10	20	30	CV (%)
Rate of return (marketing of live animal) (%)	3.15	5.89	11.42	16.38	38.88
Rate of return (slaughtered animal) %	2.92	5.51	10.74	15.42	39.13
Profitability (live animal) (%)	75.64	84.47	90.69	93.04	15.91
Profitability (slaughtered animal) (%)	74.22	83.57	90.14	92.64	18.19

CV: coefficient of variation.

In addition, the uses of by-products in animal feed have a major impact on reducing environmental pollution.

CONCLUSION

Under the conditions in which this research was developed, the inclusion of up to 10% sunflower cake in the diet of lambs, in replacement of soybean meal, increases economic viability.

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