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Reuter de Oliveira, Euclides; Pinto Monção, Flávio; de Araújo Gabriel, Andréa Maria; Mendes Fernandes, Alexandre Rodrigo; de Almeida Nascimento, Felipe; de Souza Abreu, Felipe; do Valle Mendes da Silva, Leandro; Pereira da Silva, Loan Henrique
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Characteristics of carcasses and meat from feedlot lambs fed with sunflower cake

Características da carcaça e da carne de cordeiros confinados alimentados com torta de girassol

Euclides Reuter de Oliveira[1]; Flávio Pinto Monção[2*];
Andréa Maria de Araújo Gabriel[1]; Alexandre Rodrigo Mendes Fernandes[1];
Felipe de Almeida Nascimento[3]; Felipe de Souza Abreu[4];
Leandro do Valle Mendes da Silva[5]; Loan Henrique Pereira da Silva[5]

Abstract

The aim of the experiment was to evaluate the characteristics of the carcasses and meat of feedlot lambs that received diets supplemented with sunflower cake; correlations among the variables were also performed. The experimental design was a randomized block design with four treatments (sunflower cake added at 0, 10, 20, and 30% dry matter to the base diet) and seven replications per treatment. The diets were formulated with genotypes of *Cynodon* hay and corn- and soybean meal-based concentrate that were premixed at the ratio of 50:50 (hay:concentrate) and were fed to the lambs in two portions daily at 08:00 and 14:00. The feed conversion of the animals was adversely affected ($P<0.05$) by the increase in the feedlot period in the individual stalls. For each additional day of confinement, the feed conversion increased by 0.0096 kg DM/kg of weight gain. Based on the linear regression model for the average loin pH, one hour after slaughter, the pH was reduced by 0.04 units. The marginal change in pH between the longest and the shortest times after slaughter was 14.11%. The weights of the animals at slaughter were not significantly correlated with the carcass yields. Sunflower cake is a suitable dietary supplement for lambs in intensive production systems and can be a substitute for soybean meal at up to 20%.

Key words: By-products, feed conversion, pH, sheep, yield

Resumo

Objetivou-se por meio deste experimento avaliar o desempenho e características da carcaça e da carne de cordeiros confinados recebendo torta de girassol na dieta, bem como suas correlações. O delineamento empregado foi bloco ao acaso com quatro tratamentos (0, 10, 20, 30% de inclusão de

[1] Profs. Drs., Faculdade de Ciências Agrárias, Universidade Federal da Grande Dourados, UFGD, Dourados, MS, Brasil. E-mail: euclidesoliveira@ufgd.edu.br; andrea.gabriel@ufgd.edu.br; alexandrefernandes@ufgd.edu.br

[2] Discente do Curso de Doutorado do Programa de Pós-Graduação em Zootecnia, Faculdade de Ciências Agrárias e Veterinária, Universidade Estadual Paulista "Júlio de Mesquita Filho", UNESP, Bolsista FAPESP, Jaboticabal, SP, Brasil. E-mail: moncaomoncao@yahoo.com.br

[3] Discente do Curso de Mestrado do Programa de Pós-Graduação em Zootecnia, Faculdade de Ciências Agrárias e Veterinária, Universidade Estadual Paulista "Júlio de Mesquita Filho", UNESP, Jaboticabal, SP, Brasil. E-mail: phelipe_nascimento@hotmail.com

[4] M.e em Zootecnia, Faculdade de Ciências Agrárias, UFGD, Dourados, MS, Brasil. E-mail: felipessabreu@yahoo.com.br

[5] Discentes de Graduação do Curso de Zootecnia, Faculdade de Ciências Agrárias, Universidade Federal da Grande Dourados, Dourados, MS, Brasil. E-mail: valle_leandro@hotmail.com; henriqueloan@hotmail.com

* Author for correspondence

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torta de girassol na ração base na matéria seca) com sete repetições. As rações foram formulados com fenos de genótipos de *Cynodon* e concentrado a base de Milho, farelo de soja e premix na relação de 50:50 (Feno: Concentrado),fornecidas em duas porções diária às 8:00 e 14:00 horas. O incremento no tempo de confinamento, afetou negativamente (P<0,05) a conversão alimentar dos animais. Verificou-se que para cada dia aumentado no confinamento, houve adição de 0,0096 kg de MS/ kg de peso ganho na conversão alimentar. Verificou-se que as médias do pH do lombo ajustaram-se ao modelo linear de regressão, sendo observado que à medida que aumentou uma hora após abate, houve redução de 0,04 unidades no pH. A variação marginal do pH entre o maior e menor tempo após abate foi de 14,11%. O peso dos animais ao abate não apresentou correlação significativa com os rendimentos na carcaça. A torta de girassol pode ser utilizada em suplementos para cordeiros em sistemas intensivos de produção, em substituição parcial ao farelo de soja em até 20%.
Palavras-chave: Coprodutos, conversão alimentar, pH, ovinos, rendimento

Introduction

The increase in demand for quality meat and the competitiveness with other markets require more efficient techniques in the current animal production systems in Brazil.

Among the animal production systems, the intensive production of lambs is a notable reflection of the increased market demand, particularly in the central region of Brazil. To supply the demand, feedlot strategies are used to finish the animals at an early stage and to obtain carcasses that are homogenous. However, animal feed is one of the factors that increases the cost of production, primarily in intensive or semi-intensive production systems (AZEVEDO et al., 2012). Thus, the alternative feeds supplied by the agro-industry such as cakes, sharps and other derivatives have received special attention, particularly when these alternative feeds are low in cost for a specific region (MONÇÃO et al., 2014).

Sunflower cake is a by-product of the processing of sunflower grain (*Helianthus annuus L.*), which is an annual dicot in the family *Compositae* 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 and energy 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% (DOMINGUES et al., 2010; GOES et al., 2012). However, the correlations between the qualitative characteristics of the meat and carcass with the diet of the animal *in vivo* as a decision-making tool have not been adequately investigated. Furthermore, when new ingredients are introduced in the diet, such as sunflower cake, the feedlot performance of the animal and the characteristics related to the carcass, which are essential in the consumer evaluation of meat quality, must be examined.

Therefore, the aims of this study were to determine 1) the optimum level of sunflower cake addition to the animal feed, with evaluations of feed conversion efficiency over time and 2) the correlations between slaughter weights and the characteristics of the carcasses and meat of feedlot lambs.

Materials and Methods

The experiment was conducted in accordance with the rules approved by the ethics and biosafety committee of the institution, the Universidade Federal da Grande Dourados, for the use of animals in research under protocol number 223/07.

The experiment was conducted in the Zootecnia sector of the Agricultural Sciences Faculty, Federal University of Grande Dourados-FCA/UFGD, located in the city of Dourados-MS.

Twenty-eight male Suffolk crossbred sheep that were 4 months of age and an average weight of 21±0.38 kg were used. The animals were distributed into weight categories (low, medium and high) and four treatment groups (control (0), 10, 20, and 30% additions of sunflower cake to the base diet) with seven replications in a randomized block design. The animals were identified with numbered earrings and were dewormed with 1% ivermectin by mouth to control endo- and ectoparasites.

The animals were maintained for an average period of 120 d under confined conditions, which was preceded by 14 days for adaptation to the management and diets. The sheep were randomly assigned to individual 1.5 m^2 stalls in 2 covered sheds with concrete floors that were lined with shavings, and the stalls had curtains for temperature control, a drinker and a mobile trough.

The diets were formed from the control treatment in which corn and soybean meal were the sources of protein and energy. In the other treatments, the sunflower cake was added at 10%, 20% and 30% and replaced corn and soybean meal in the base diet; the four treatments were isoproteic, averaging 17,94% CP (DM).

The diets, based on volume, were composed of Tifton 85, Tifton 68 and Jiggs (*Cynodon* spp.) hay, a concentrate composed of ground corn, minerals, and soybean meal and sunflower cake (control, 10, 20, and 30% addition of sunflower cake to the base diet) and were formulated according to the NRC (2007) to meet the nutritional requirements of animals to gain 200 g/day (Table 1).

Table 1. Composition of experimental diets according to the sunflower cake inclusion levels in the concentrate

Ingredients	Level of inclusion of sunflower cake			
	0%	10%	20%	30%
Foods	Composition in% DM			
Hay *Cynodon*	50.00	50.00	50.00	50.00
Sunflower cake	0.00	10.00	20.00	30.00
Corn Grain Ground	29.65	22.71	15.77	8.83
Soy bean meal	19.41	16.37	13.33	10.29
Mineral premix	0.20	0.20	0.20	0.20
Calcareous	0.73	0.71	0.69	0.68
Components	Bromatological composition (% DM)			
Dry Matter	87.24	87.26	88.37	88.77
Crude Protein	17.98	18.15	17.97	17.66
Ether extract	1.27	3.43	5.63	7.18
NDF	60.22	61.96	62.54	60.33
ADF	30.51	29.83	29.51	26.80
*TDN	56.60	55.60	55.30	56.54
Mineral matter	6.63	7.01	6.50	6.72

* Estimate as Cappelle et al. (2001) (TDN = 91,0246 - 0,571588*NDF); Mineral mixture for ovines (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; fluorine (max) = 720 mg/kg).

The sunflower cake was obtained from the mechanical pressing of grain without using solvents, and all plant material was processed in a single period on a single machine (MUE-100 for

cold extraction).

The experimental diet was based on a pre-trial phase in which the amount provided was based on individual consumption. The forage:concentrate ratio of 50:50 was determined on the basis of dry matter (DM). The daily consumption of the diets was determined based on 5% to 10% of the food remaining. The feed was provided twice daily at 08:00 and 14:00.

All the food provided, including the remains, was weighed to calculate the feed conversion. The weights of the animals were measured at the beginning of the experiment and at 14-d intervals, after a period of fluid and solid fasting for 16 h, using a mechanical scale with a capacity of 100 kg.

At the end of the experiment, the animals were slaughtered in the experimental slaughterhouse of "Fazenda experimental da UFGD" following the stunning procedures for electronarcosis and the subsequent bleeding by sectioning of the jugular veins and carotid arteries (CEZAR; SOUZA, 2007). The hot carcass weights were obtained at slaughter, and the carcass yields were obtained from the ratios between hot carcass weights (HCW) and slaughter weights (SW) of the animals. The carcasses were transported to a refrigeration chamber for 24 h at 3ºC. After this period, the carcasses were weighed to obtain the cold carcass weights (CCW), and the cold carcass yields (CCY) were calculated from the ratios between the weights of chilled carcasses (PCR) and the slaughter weights (SW). The pH was measured (potential of hydrogen) with a digital pH meter (model IPHPJ, Jonhis mark) by introducing the electrode directly into the *Triceps brachii* palette muscle, the *Semimembranosus* leg muscle, and the *Longissimus lumborum* loin muscle, with three measurements taken in each location on the right side of carcass.

In a transverse cut between the 12th and 13th ribs, a caliper was used to measure the thickness of the exposed fat in the third quarter of the *Longissimus dorsi* muscle from the spine. The area of the loin eye was measured by tracing the perimeter of the muscle on vegetable parchment, which was followed by planimetry using AutoCAD R14 software, as described by Oliveira et al. (2010).

Three samples approximately 2.5 cm in thickness of the *Longissimus dorsi* muscle were removed from the 12th rib and immediately sent to the laboratory for analysis of the meat color. The meat color determinations were performed as described by Houben et al. (2000), using a colorimeter (Konica Minolta ®). Thirty minutes before the evaluations, a cross-section of the muscle exposed the myoglobin to oxygen, as described by Fernandes et al. (2011).

In the sensorial analysis, the meat samples received an addition of 1,5% salt based on the weights and were roasted in a preheated oven at 175ºC until the internal temperature of the meat reached 75°C. The tasting was conducted by 20 trained tasters, with a nine point hedonic scale that considered the texture attribute (i.e., the perception of strength required to shear the sample when biting).

The levels of sunflower cake addition to the diets were evaluated with orthogonal contrasts for which the best fit was obtained by testing linear, quadratic and cubic models with the SAS Statistical Software package (2008).

Correlations were performed among the characteristics of performance (slaughter weights and yields), the carcass (internal carcass length, fat thickness, loin eye area and marbling) and the meat quality (texture and color) using the CORR procedure in the SAS statistical software package (SAS, 2008).

Results and Discussion

The inclusion of 30% of sunflower cake in the diet of lambs negatively affected the performance of animals (Table 2). There was a significant linear decrease of 0.15; 0.11; 0.12 and 0.002% in slaughter weight (SW), hot carcass weight (HCW), cold

carcass weight (CCW) and compactness index (CI), respectively when it increased 1% in the inclusion of the sunflower cake in the diet (Table 2).

Consequently, the hot carcass (HCY) and cold carcass yields (CCY) decreased with the additions of sunflower cake. Based on the linear regression model, the HCY and the CCY decreased 0.13% and 0.16%, respectively, for each percentage unit of sunflower cake added to the diet. The differences in the HCY and the CCY between the groups that received the highest level of addition and the controls without the addition of sunflower cake were 7.36% and 10.05%, respectively. Most likely, these reductions in yield occurred because of the variability in the absolute values of the SW, HCW and CCW with the additions of sunflower cake to the diet.

Table 2. Final live body weight, cold carcass weight, gross income and net revenue of feedlot lambs fed diets with different levels of sunflower cake

Variable	Inclusion Level(%)				
	0	10	20	30	CV
Weight at slaughter(kg)[1]	37.04	34.16	35.79	31.47	7.24
Hot carcass weight (kg)[2]	16.95	15.49	15.00	13.27	6.91
Cold carcass weight(kg)[3]	16.21	14.69	14.26	12.34	6.48
Hot carcass yield(%)[4]	45.74	45.38	41.91	42.38	5.93
Cold carcass yield(%)[5]	43.74	43.08	39.86	39.34	4.14

$\hat{Y}^1 = 36{,}87 - 0{,}15^{**}X$, $R^2 = 0{,}65$; $\hat{Y}^2 = 16{,}90 - 0{,}11^{**}X$, $R^2 = 0{,}96$; $\hat{Y}^3 = 16{,}17 - 0{,}12^{**}X$, $R^2 = 0{,}95$; $\hat{Y}^4 = 45{,}88 - 0{,}13^{**}X$, $R^2 = 0{,}77$; $\hat{Y}^5 = 43{,}97 - 0{,}16^{**}X$, $R^2 = 0{,}90$. CV - Coefficient of Variation.

For the feed conversion (FC), a significant difference was detected for the feedlot period of the lambs that were affected by the levels of sunflower cake addition (Table 3). However, the interaction between inclusion level and feedlot period was not significant (P> 0.05).

Table3. Effect of sunflower cake and feedlot period on feed conversion (FC) of lambs.

Inclusion Levels (%)	Time (Days)				Averages
	30	60	90	120	
	Feed Conversion				
0	4.56	5.07	5.26	5.34	5.05
10	4.79	5.55	5.45	5.37	5.29
20	4.84	5.99	6.23	5.73	5.70
30	6.26	7.04	7.35	7.26	6.98
Averages	5.11	5.91	5.92	6.07	
CV(%)			21.55		
MSE			0.2346		

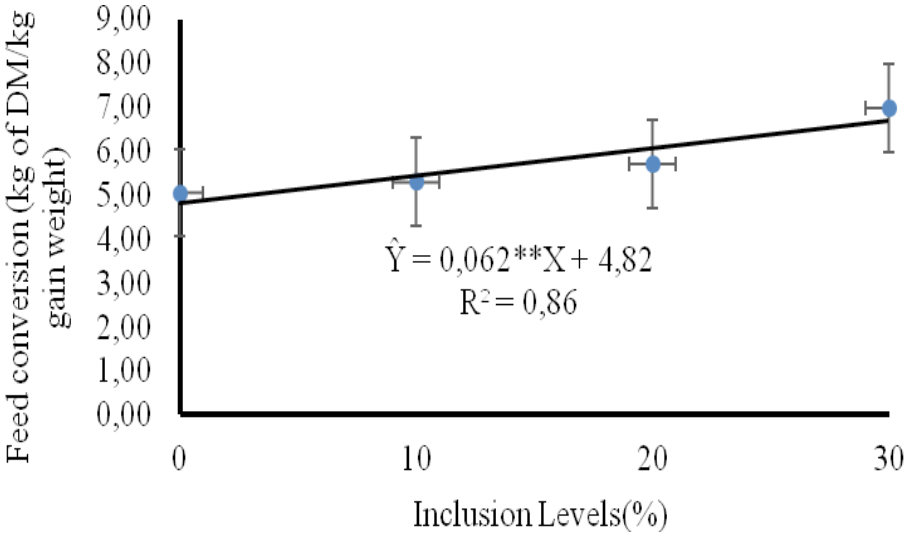
CV- Coefficient of Variation; MSE- Mean Standard Error.

For each 1% increase in the level of sunflower cake addition, a linear increase occurred in the FC of 0.062 kg of DM/kg of weight gain (Figure 1). The marginal variation was 38.21% between the

control group (without sunflower cake) and the group that received 30% of sunflower cake. These results were explained by the high content of ether extract (Table 1) in the diet with the 30% addition of sunflower cake, which might have limited the nutrient intake and negatively affected the weight gain and the FC.

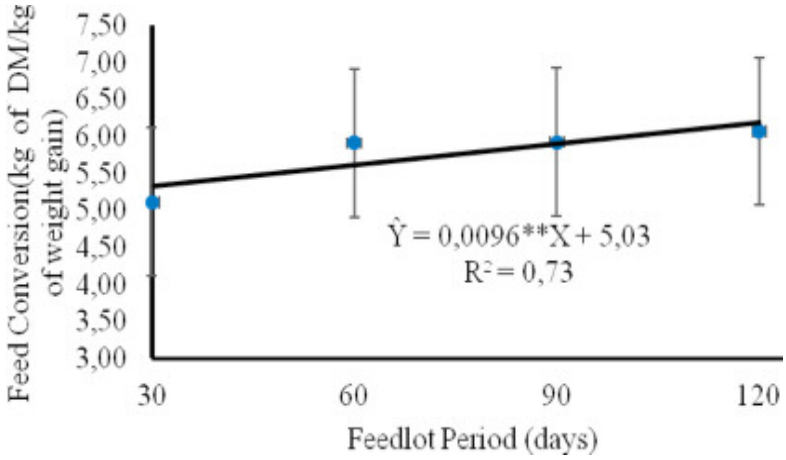
Diets with a high content of ether extract (above 5%) lead to an increase in consumption (PALMQUIST; MATTOS, 2006) and the consequent activation of ruminal receptors, which enable the satiety center, controlled by the hypothalamus, to inhibit the intake of dry matter. However, the amount of ingested amino acids is not sufficient to satisfy the demand of the ruminal microflora, limiting microbial protein synthesis by the ruminal bacteria. Thus, the efficiency of nutrient use is reduced in these diets and results in lower performance, as noted in the FC results for the diet with 30% sunflower cake. Another important factor that might explain the high FC in the diet with 30% sunflower cake was that the high content of ether extract (7.18%, unsaturated fatty acids; Table 1) might have intoxicated the ruminal microorganisms in addition to forming a skin over the feed particles and reducing microbial adhesion and rumen fiber degradation (KOZLOWSKY, 2011). Therefore, animal performance was affected by the reduced rate of food passage from the rumen to the small intestine, which reduced nutrient availability for digestion and absorption.

Figure 1. Sunflower cake effect in the diet of lambs crossbred Suffolk on feed conversion.



Based on the regression, an increase in the length of the feedlot period also negatively affected the FC of the animals, and for each additional day in the feedlot there was an additional 0.0096 kg of DM/kg of weight gain (Figure 2) in the FC.

Figure 2. Feed conversion (FC) of sulfolk crossbred lambs fed with diets containing sunflower cake in feedlot.



The increase in the FC of animals with more time in confinement might be related to the change in the growth curve of the animal because the increased deposition in muscles reduced the time required for the animal to reach early physiological maturity. From this stage of early maturity, the animal deposited more fat in the carcass because of the increase in the intake of nutrients and the reduction in weight gain, as shown in this research. The marginal variation in the FC between the longest and shortest feedlot periods was 15.81%. According to Moreno et al. (2010), one of the strategies to minimize the FC in feedlots is to wean the lambs later when they are heavier, which is reflected in a shorter feedlot period and an improved FC.

For the parameters evaluated for the carcasses, such as the pH, no significant differences among the levels of sunflower cake addition or for the interaction (P> 0.05) between the sunflower cake levels and the time after slaughter were detected. However, significant differences in the pH were observed among measurement times in the carcass after slaughter (Table 4).

Table 4. Sunflower cake effect and the time after slaughter over the pH of loin lambs in feedlot.

Inclusion Levels (%)	Period (hours)					Average
	0	6	12	18	24	
	pH of Loin					
0	6.54	6.27	5.85	5.74	5.68	6.02
10	6.60	6.32	5.95	5.77	5.66	6.06
20	6.65	6.37	5.92	5.70	5.64	6.05
30	6.58	6.21	5.76	5.72	5.67	5.99
Average	6.59	6.29	5.87	5.73	5.66	
CV(%)	3.35					
MSE	0.0763					

CV- Coefficient of Variation; MSE- Mean Standard Error.

Figure 3 shows that as the time after slaughter increased the pH values were reduced linearly up to 12 h, with wide variations among the averages up to 24 h; thereafter, the variability of the pH values

was reduced, and the pH stabilized at approximately 5.7. Thus, based on the best fit to a linear regression model, within one hour after slaughter, the pH decreased by 0.04 units. The marginal pH variation between the longest and the shortest times after slaughter was 14.11%.

Pinheiro et al. (2009) evaluated the pH of the loin muscles (*Longissimus lumborum*) of lambs of the variety Ile de France vs. Ideal and reported values of 6.53 and 5.53 45 min and 24 h after slaughter, respectively, which corroborates the results with this research. The reduction in the pH of the carcasses possibly occurred in response to the reduction of glycogen and led to an increase in lactic acid fermentation by muscle cells to survive. Thus, with the accumulation of lactic acid in the carcasses, the gradual reduction in pH occurred, as observed in this research.

The associated reduction in the pH and in the carcass temperature is critically important in the storage process and in the shelf life of the meat cuts. In this research, for the pH values in the palette of the lambs, no significant interaction between the cake levels and time after slaughter was detected (Table 5). However, there was an effect (P <0.05) from sunflower cake levels and the time after slaughter.

Figure 3. Effect of the period after slaughter on pH Carcass (*Longissimus lumborum*) of Sulfolk crossbred lambs finished in feedlot.

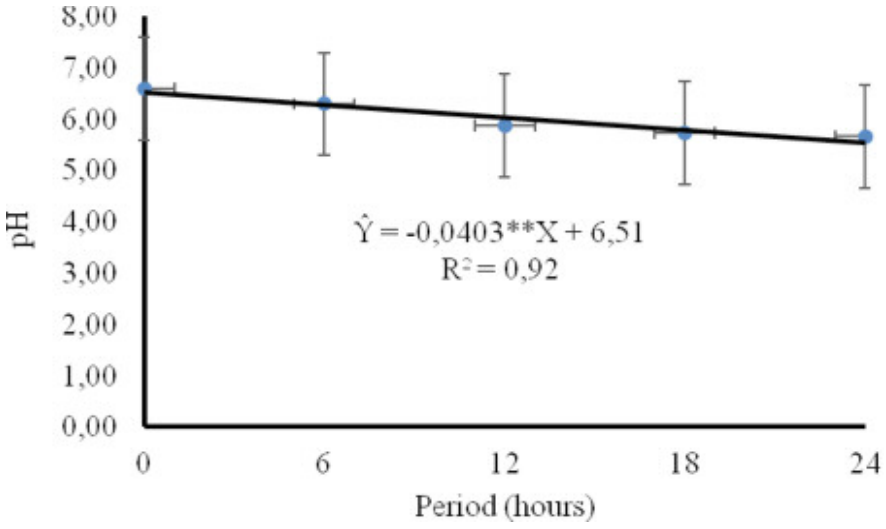


Table 5. Sunflower cake effect and the period after slaughter over the pH of the lambs palette in feedlot.

Inclusion Levels (%)	Period (hours)					Average
	0	6	12	18	24	
	pH of Palette					
0	6.62	6.17	6.01	5.93	5.76	6.10
10	6.67	6.38	6.18	6.04	5.92	6.24
20	6.55	6.14	5.95	5.76	5.71	6.02
30	6.71	6.35	6.12	6.03	5.95	6.23
Average	6.64	6.26	6.07	5.94	5.83	
CV(%)	3,00					
MSE	0.0311					

CV- Coefficient of Variation; MSE- Mean Standard Error.

Although the increase in the pH of the palette was small, the increased levels of sunflower cake addition increased the pH values 0.0018 units for each 1% addition of the sunflower cake (Figure 4).

Pinheiro et al. (2009) reports pH values of 6.00 for the palettes of lambs, which approximated the values observed in this research. In the period after slaughter, the averages were fit to a linear regression model, as shown in Figure 5.

For each additional hour after slaughter, the pH decreased 0.03 units, indicating that the reduction was gradual, which is notable because of the undesirable aspects such as protein denaturation that occur when the pH is reduced abruptly and the temperature is elevated. Fernandes et al. (2011) report that the speed in the reduction of the pH and the final pH affect the water retention capacity, which is a qualitative characteristic of great importance because it affects the appearance, the behavior of the meat during cooking, and the juiciness during chewing. According to Lawrie (2005), the water is maintained by capillarity and is associated with proteinaceous filaments. Thus, the normal glycolysis *postmortem* occurs until a final pH of approximately 5.5, the isoelectric point of the major muscle proteins responsible for the water retention capacity, is reached.

Figure 4. Sunflower cake effects on the diet for lambs over the pH of the palette.

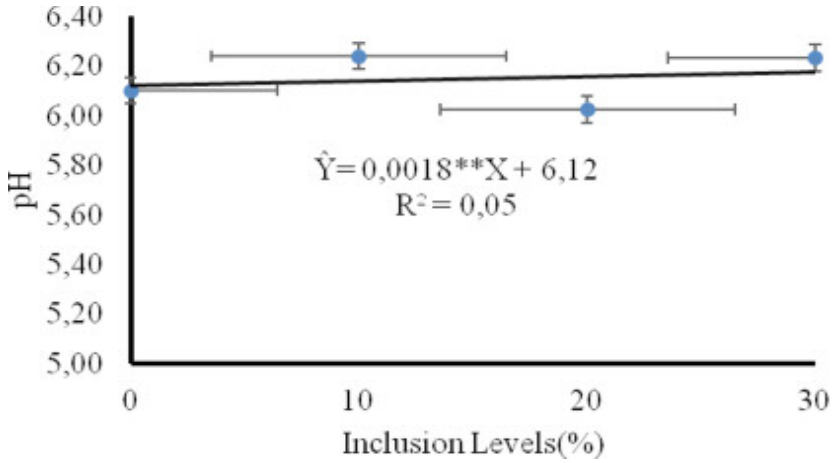
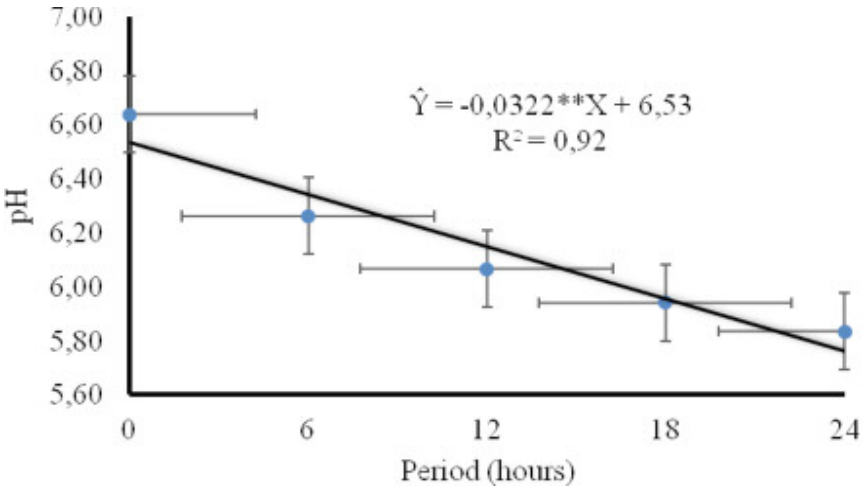


Figure 5. Effect of the period after slaughter, over the pH of palette of Sulfolk crossbred lambs finished in feedlot.



The average pH values for the loin, palette and leg muscles (Table 6) 24 h after slaughter were approximately 5.66, 5.83 and 5.63, respectively. These values are normal for sheep meat, according to the work of Pinheiro et al. (2009) who report average values of 5.53, 5.50 and 5.55, respectively, for different categories of animals. According to Cezar and Souza (2007), final pH values lower than 5,4 result in PSE meat (pale, soft, and exudative), which is rarely observed, particularly in ovines. The PSE condition decreases the water retention capacity, and therefore, the meat is flaccid and pale, negatively affecting consumer acceptance. However, at values above 6.0, the meat darkens (DFD-dark, firm, and dry) and water retention capacity and enzyme activity increase in the meat, reducing the shelf life (LAWRIE, 2005).

A significant interaction between the level of sunflower cake and the time after slaughter was not observed for the pH of the leg. However, there were differences (P <0.05) among the average pH values of the leg in response to the level of sunflower cake and the time after slaughter.

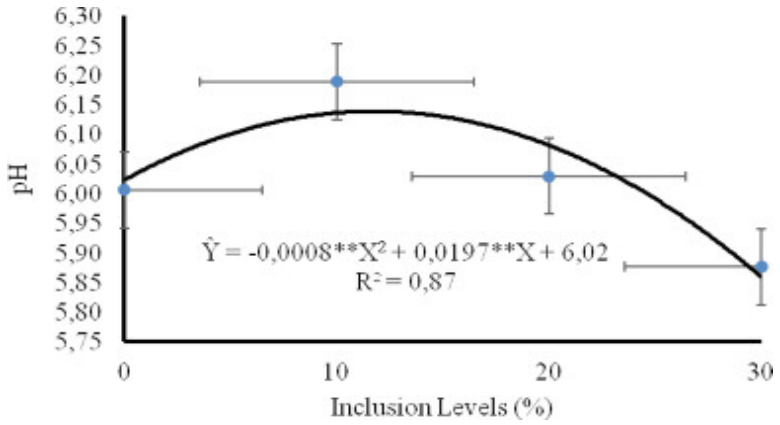
Table 6. The effect of sunflower cake and time after slaughter over the pH of the lambs leg in feedlot.

Inclusion Levels (%)	Time after slaughter (hours)					Average
	0	6	12	18	24	
	Leg pH					
0	6.67	6.21	5.83	5.68	5.64	6.01
10	6.83	6.44	6.22	5.81	5.64	6.19
20	6.64	6.07	5.91	5.83	5.70	6.03
30	6.56	6.01	5.71	5.57	5.53	5.88
Average	6.68	6.18	5.92	5.72	5.63	
CV(%)	3.85					
MSE	0.0392					

CV- Coefficient of Variation; MSE- Mean Standard Error.

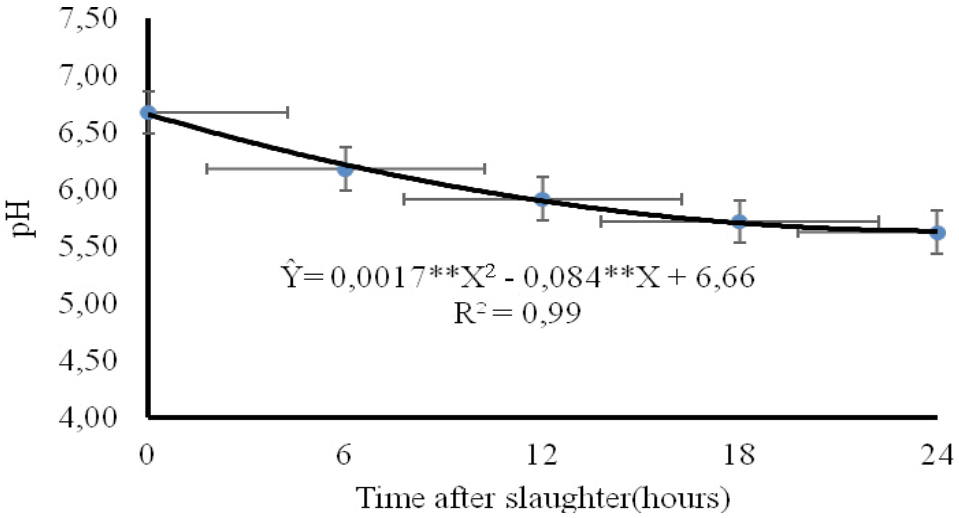
The averages were fit to a quadratic regression model with the increments of sunflower cake, and the cake level that maximized the pH value was 12.31% (Figure 6).

Figure 6. Effects of sunflower cake inclusion in the diet to lambs over the pH of the leg.



The average pH values of the leg over time were also fit to a quadratic regression model from which the period with the lowest pH value was 24.70 h after slaughter (Figure 7).

Figure 7. Time effect after slaughter, over the leg pH of Sulfolk crossbred lambs finished in feedlot.



Based on the correlation analyses, the SW of the lambs was not significantly correlated with the HCY, CCY, ICL, SFT, COLOR, MARB or AOL and was negatively correlated (r = -0,08, P <0,05) with the meat TEX (Table 7). These results were corroborated by Goes et al. (2012) in the evaluation of the performance and the characteristics of carcasses of heifers fed up to 60% of sunflower cake in their diet; they did not find a correlation between the SW and the ICL. However, Oliveira et al. (2010) found a positive correlation between the SW and the ICL.

Table 7. Pearson correlation between the performance variables of carcass and meat from lambs fed with sunflower cake.

Variables	HCY	CCY	ICL	SFT	TEX	COLOR	MARB	AOL
SW	-0.02ns	0.10ns	0.25ns	0.40ns	-0.08 *	-0.28ns	0.49ns	0.07ns
HCY		0.90***	0.07ns	0.09ns	0.28ns	-0.07ns	0.01ns	0.36ns
CCY			0.11ns	0.17ns	0.40 *	0.01ns	0.05ns	0.37*
ICL				0.46 *	0.16ns	-0.01ns	0.05ns	0.37ns
SFT					0.20ns	-0.08ns	0.27ns	0.23ns
TEX						0.33ns	0.07ns	0.09ns
COR							-0.27ns	-0.06ns
MARB								0.18ns

SW- Slaughter Weight; HCY- Hot carcass yield; CCY- Cold carcass yield; ICL- Internal carcass length; SFT- Subcutaneous fat thickness; TEX- Texture; MARB- Marbling. ***- (P<0,001); **- (P<0,01); *-(P<0,05).

The HCY was highly correlated (r = + 0.90) with the CCY; therefore, with a high HCY and low losses during the cooling of the carcass, the CCY increased. The correlation these two variables permits estimations of the characteristics of the carcasses and the meat, when specific and accurate equipment is not available. The CCY was also positively correlated (P <0.05) with the TEX (r = 0.40) and with the AOL (r = 0.37).

The ICL was positively correlated (r = 0.46) with the SFT, an observation also reported by Oliveira et al. (2010) for Nelore heifers. For these authors, the muscularity and fat finish degree are very important in the carcass evaluation. Moreover, the loin eye area and the fat thickness, both measured at the height of the 12th rib, are internationally accepted indicators of muscularity and the amount of fat (LUCHIARI FILHO, 2000).

The color and the marbling of the meat were not significantly correlated with the other characteristics. The marbled fat is the last fat deposited on the carcass, and consequently, the expectation was that animals with a high slaughter weight would be positively correlated with marbling. However, this expectation was not realized in this research, possibly because of the feedlot period for the animals. Notably, this result affects the assessment of the commercial price of the meat because to retain heavy animals in feedlots with the expectation of increased increments of fat marbling increases the cost of production.

For the color and the texture of the meat in the carcasses, Cezar and Sousa (2007) affirmed that the primary factor was the age of the animal, which most likely explained the similarity in meat color and texture in this report (r = 0.33 ns) because the lambs were all 4 months in age.

Conclusions

For lambs in intensive production systems, sunflower cake can be used as a supplement for up to 20% of the diet and should be considered, depending on the availability and cost of the product in a region.

The slaughter weights of the animals were not correlated with the yields or the characteristics of the meat.

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