Research, Society and Development, v. 9, n. 9, e682997667, 2020
(CC BY 4.0) | ISSN 2525-3409 | DOI: http://dx.doi.org/10.33448/rsd-v9i9.7667

Qualidade da carcaça e da carne de cordeiros alimentados com óleo ou semente de girassol

Carcass and meat quality of lambs fed with sunflower seed or oil

Calidad de la canal y la carne de corderos alimentados con aceite o semillas de girasol

Received: 17/08/2020 | Reviewed: 27/08/2020 | Accept: 02/09/2020 | Published: 03/09/2020

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Resumo

O objetivo deste estudo foi comparar o uso de semente e de óleo de girassol como fonte de gordura na dieta de cordeiros em terminação. Doze cordeiros mestiços Santa Inês × Dorper, com peso médio inicial de 22,10 ± 3,82 kg, foram alojados em baias individuais e divididos em dois tratamentos: dietas com sementes de girassol ou óleo. A dieta total de ambos os grupos continha 33% de volumoso (feno de capim-tifton 85) e 67% de concentrado. A proporção de óleo de girassol e sementes na matéria seca total das dietas foi de 1,83% e 5,51%, respectivamente para os tratamentos óleo e semente. O período experimental durou 75 dias. Os animais foram abatidos quando atingiram peso vivo médio de 35 kg. As variáveis da carcaça e da carne não diferiram entre os tratamentos estudados. A presença de óleo ou semente de girassol nas dietas, ambos com alto teor de concentrado (67%), não influenciou os valores de pH da carne, para as quais os valores médios obtidos foram 5,8 e 5,6, respectivamente. A utilização de 5,5% de semente de girassol ou 1,8% de óleo de girassol, como fontes de gordura nas dietas de cordeiros mestiços Santa Inês X Dorper em terminação, foram eficazes na obtenção de carne e carcaças de qualidade.

Palavras-chave: Confinamento; Espessura de gordura subcutânea; Peso da carcaça; Rendimento de carcaça; Subproduto.

Abstract

The objective of this study was to compare the use of sunflower seeds and oil as a fat source in the diets of finishing lambs. Twelve crossbred Santa Inês × Dorper lambs, with an average initial weight of 22.10 ± 3.82 kg were housed in individual pens and divided into two treatments: diets with sunflower seeds or oil. The total diet of both groups contained 33% roughage (tifton grass hay 85) and 67% concentrate. The proportion of sunflower oil and seeds in the total dry matter of the diets was 1.83% and 5.51%, respectively for the treatments oil and seed. The experimental period lasted for 75 days. The animals were slaughtered when they reached an average live weight of 35 kg. The carcass and meat variables were not different between the treatments studied. The presence of oil or sunflower seeds in the diets, both with a high level of concentrate (67%), did not influence the pH values of the meat, with average values of 5.8 and 5.6, respectively. The use of 5.5% sunflower seed, or 1.8% sunflower oil, as fat sources in diets of crossbred Santa Inês X Dorper lambs in finishing, were effective to obtain quality meat and carcasses.

Keywords: Feedlot; Subcutaneous fat thickness; Carcass weight; Carcass yield; Byproduct.

Resumen

El objetivo de este estudio fue comparar el uso de semillas y aceite de girasol como fuente de grasa en la dieta de corderos en finalización. Doce corderos cruzados Santa Inês × Dorper, con un peso inicial promedio de 22,10 ± 3,82 kg fueron alojados en corrales individuales, los cuales se dividieron en dos tratamientos: dietas con semillas o aceite de girasol. La dieta total de ambos grupos contenía 33% de fibra (heno de pasto tifton 85) y 67% de concentrado. La proporción de aceite y semillas de girasol en la materia seca total de las dietas fue de 1,83% y 5,51%, respectivamente para los tratamientos aceite y semilla. El período experimental duró 75 días. Los animales fueron sacrificados cuando alcanzaron un peso vivo promedio de 35 kg. Las variables de canal y carne no fueron diferentes entre los tratamientos estudiados. La presencia de aceite o semillas de girasol en las dietas, ambas con alto nivel de concentrado (67%), no influyó en los valores de pH de la carne, con valores promedio de 5,8 y 5,6, respectivamente. El uso de 5,5% de semilla de girasol o 1,8% de aceite de girasol, como fuentes de grasa en dietas de corderos cruzados Santa Inês X Dorper en finalización, fueron eficaces en la obtención de carnes y canales de calidad.

Palabras clave: Confinamiento; Espesor de la grasa subcutánea; Peso de la canal; Rendimiento en canal; Subproducto.

1. Introduction

Lamb confinement is a nutritional tool to intensify production systems and obtain carcasses and meat with quality in a shorter time period, compared to pasture production. Studies with the use of co-products are relevant to livestock, seeking not only to reduce production costs, but also to improve the quality of the final product that reaches the consumer.

Sunflower (*Helianthus annuus* L.) is a food that can be used in the formulation of animals' diets, with interesting results, mainly due to its nutritional characteristics, being rich in protein and energy. Sunflower also stands out for being among the foods with the highest levels of essential fatty acids, being an excellent option for formulating diets (Silva, 1990).

In Brazil, the production of sunflower seeds started to increase in 1996 to produce oil (Freitas, Ferreira & Tsunechiro, 1998). In the last harvest, world production between grain, bran and oil of sunflower was approximately 45 million tons of grains, an increase of 11% compared to the previous harvest (CONAB, 2019).

The use of lipids in different forms (oils or seeds) can result in differences in performance, carcass, and meat quality. The inclusion of vegetable oils, especially sunflower oil, in the ruminant diet is much less common than the use of oilseeds, as it is more complicated to manage. The use in the form of oil makes it readily available to the ruminal microbiota and has high proportions of polyunsaturated fatty acids, which can harm ruminal degradation (Jorge, et al., 2008).

In this context, the objective of this study was to evaluate the effects of sunflower seed and oil, used as a fat source in diets of finishing lambs, on carcass and meat carcass quality.

2. Material and Methods

The experiment was conducted at Universidade Norte do Paraná (UNOPAR), Arapongas, Paraná. The field phase was carried out from August to October 2017. This project was approved by the Ethics Committee on the Use of Animals (CEUA 001/17) and is in accordance with the ethical principles of animal experimentation. All analysis were described according to Pereira et al. (2018).

Twelve crossbred (Santa Inês × Dorper) non-castrated male lambs, with approximately 60 days of age and an average initial weight of 22.10 ± 3.82 kg, were housed in individual, cemented, and covered pens, which contained a drinking fountain and feeder. The animals were divided into two groups of 6 animals, called "sunflower oil" and "sunflower seed". Animals in both groups received 33% roughage (tifton grass hay 85) and 67% concentrate. Table 1 shows the ingredients and bromatological composition of the diets.

Table 1 - Ingredients and the bromatological composition of experimental diets (DM%) of lambs fed diets containing oil or sunflower seeds.

Ingredients (%)	Sunflower oil	Sunflower seeds
Tifton hay	33.01	33.05
Ground corn	34.21	32.71
Soybean meal	29.92	27.72
Sunflower seeds	-	5.51
Sunflower oil	1.83	-
Mineral salt	1.01	1.01
Monensina	0.0015	0.0015
Bromatological composition (%)		
DM	90.65	90.92
MM	4.19	4.12
CP	17.60	20.02
EE	3.84	4.34
NDF	33.21	34.68
ADF	19.09	20.10
TND	69.89	67.40

DM: dry matter; MM: mineral matter; CP: crude protein; EE: ethereal extract; NDF: neutral detergent fiber; ADF: acid detergent fiber; TDN: total digestible nutrients.
Source: Authors.

The diets were prepared according to the recommendations of the NRC (2007), to meet the requirements of weaned lambs, with weight gains of 200 g per day, and became nutritionally similar. The ingredients (Table 1), as well as the total diet, regarding the dry matter (DM), mineral matter (MM), crude protein (CP), ethereal extract (EE), neutral detergent fiber (NDF), and acid detergent fiber (ADF) contents used were according to the methodologies described by Mizubuti et al. (2009). The total digestible nutrients (TDN) were estimated according to Capelle et al. (2001), by the equation TDN = -3,84+1,064*DMD and dry matter digestibility (DMD) was obtained by DMD = 82,5353 – 0,3333*NDF (Tibo, 1999). Bromatological analyses were carried out at the UNOPAR Bromatology Laboratory.

The sunflower seed nutritional values were: 97% DM, 4% MM, 15% CP, 43.86% EE, 56% NDF, 35.98% ADF, and 62.58% TDN. Nutritional values obtained to Tifton hay were 93.25% DM, 5.50% MM, 8.80% CP, 0.40% EE, 64.92% NDF, 39.66% ADF, and 59.26% of TDN.

The diets were provided twice a day, at 08:00 and 16:00 hours every day. The amount of seed and sunflower oil was individually measured and added to the total diet at the time of supply, ensuring that the animals received the exact amount needed. The orts were collected and weighed (kept around 15% of the offer) before the morning treatment to adjust the quantity offered. The confinement period was 75 days, with seven days of adaptation and 68 days of experiment. The animals were weighed on day zero of the experiment, every 21 days, and on the day of slaughter (after a 16-hour fast).

The day before slaughter, carcass measurements were assessed *in vivo* via ultrasound with a Sonoscape S6vet model, in real time, from the animal's right side, before performing the trichotomy of the region between the 12th and 13th thoracic vertebrae. The loin eye area by ultrasound (LEA1) was estimated using a multi-frequency convex transducer at a 5 MHz frequency (Junkuszew & Ringdorfer, 2005).

The animals were slaughtered on the same day, with an average body weight of 35 kg. Slaughter was carried out using humanitarian slaughter standards. Before slaughter, the animals spent 16 h fasting from solids and with unrestricted water consumption, and then they were weighed to assess the body weight at slaughter (BWS). The feet, head, and internal components were removed before the carcass was weighed to obtain the hot carcass weight (HCW). After removing the internal components, the full gastrointestinal tract was weighed. Then, it was emptied and weighed again to assess the weight of the empty gastrointestinal tract, thus making it possible to calculate the weight of the gastrointestinal content and the empty body weight (EBW), which is the body weight at slaughter minus the gastrointestinal content. After weighing the carcasses, they were stored in a cold chamber at 4 ºC for 24 h to obtain the cold carcass weight (CCW).

The hot carcass yield (HCY) was determined by the ratio between the hot carcass weight and the body weight at slaughter, multiplied by 100. The cold carcass yield (CCY) was determined by the ratio between the cold carcass weight and slaughter body weight, multiplied by 100. To determine the biological yield (BY), the ratio between the hot carcass weight and the empty body weight, multiplied by 100, was used.

The conformation variable were made according to the European classification of carcasses (superior, excellent, very good, good, normal, and poor) and degree of finishing (ranging from 1 to 5, from absent to abundant fat (Cañeque & Sañudo, 2000). Meat pH measurement was performed with the aid of a TESTO 205 digital portable pH meter (TESTO AG Germany) within 24 h postmortem.

After 24 h in a cold chamber, a portion of the Longissimus thoracis et lumborum muscle (between the 12th and 13th ribs) was removed and sent to the UNOPAR bromatology laboratory for analysis. The loin eye area of the carcass (LEA2) was determined using a digital caliper, and the maximum width (A) and maximum depth (B) were measured to determine the area according to the formula: LEA = (A / 2 * B / 2) π, according to Cezar & Sousa (2007). The subcutaneous fat thickness (SFT) in the muscle was measured using a digital caliper. The marbling rate was estimated subjectively using photographic patterns (AMSA, 2001), and scores of 1 to 10 were assigned (1 = traces of marbling and 10 = abundant marbling).

The meat sample was divided into two portions, and of one of them (approximately 50 g) was used for analyses of color, pH, and water retention capacity, performed on the same day of slaughter. Another portion, approximately 100 g, was frozen for further analysis of thawing loss (TL) and cooking loss (CL) of meat.

Meat color of the meat sample was measured using the KONICA MINOLTA portable colorimeter, color reader CR-10 (Tokyo, Japan) with D65 and a 10° illuminant angle of inclination for the evaluation of the L* (luminosity), a* (red-green component), and b* (yellow-blue component) components, which were expressed by the CIELAB color system, according to Houben et al. (2000). Measurements were taken at three points for each meat sample.

The loss of water by pressure (LWP) of the meat was evaluated by the pressure application method, weighing a sample of meat before and after the superposition of a 10 kg weight for 5 min, to obtain the value of water loss.

To estimate the thawing loss, the samples were defrosted under refrigeration (5 ºC) for 24 h. For cooking, these samples were previously weighed and roasted in a gas oven preheated to 170 °C until they reached 71 °C in their geometric center, measured using a digital thermometer. After cooking, the samples were cooled to room temperature and weighed again. The thawing and cooking losses were estimated according to the methodologies described in AMSA (2015).

The experimental design was completely randomized, considering the animal as an experimental unit. Analysis of variance were performed using the ExpDes.pt package (Ferreira, Cavalcanti & Nogueira, 2018) in the R software (2017). Analysis of normality and homogeneity of variance of the residues were also performed using the Shapiro-Wilk and Bartlett tests. For all analyses, a significance level of 5% was considered. Pearson's correlation coefficients between the variables studied were calculated.

3. Results and Discussion

Quantitative variables of the carcass (Table 2) were not different between treatments (P > 0.05). Likewise, Almeida et al. (2016) studied the inclusion of 8% of sunflower seeds combined with vitamin E in the diet of crossbreed Santa Inês × Dorper lambs, using sugar cane as roughage, and the authors found no differences in performance and carcass variables.

Table 2 - Mean and standard deviation of variables related to performance and carcass of finished lambs fed sunflower seeds or oil.

Variables*	Sunflower oil	Sunflower seeds	p-valor
BWS (Kg)	34.93±2.79	33.93±7.53	0.76
HCW (Kg)	16.36±2.01	15.90±3.15	0.76
CCW (kg)	15.80±1.83	15.51±3.06	0.84
EBW (kg)	29.96±2.96	28.85±7.15	0.72
HCY (%)	48.87±4.33	47.10±2.29	0.90
CCY (%)	45.22±3.82	45.96±2.05	0.68
BY (%)	54.64±5.03	55.71±3.70	0.68
DF (score 1 to 5)	3.50±0.83	3.83±0.98	0.54
CO (score 1 to 5)	3.66±1.03	4.00±1.26	0.62

*BWS: body weight at slaughter; HCW hot carcass weight; CCW: cold carcass weight; EBW: empty body weight; HCY: hot carcass yield; CCY: cold carcass yield; BY: biological yield; DF: degree of finishing; CO: conformation.
Source: Authors.

Hot, cold, and true carcass yields are within the standards commonly found in recent research with sheep species. In a study by Rego et al. (2019) with Texel male lambs, slaughtered with a 32.5 kg live weight, they found values between 44 and 45.7% of cold carcass yield.

The subjective measures of finishing and conformation (Table 2) did not differ significantly ($P > 0.05$) between treatments and presented mean values of 3.66 and 3.83, respectively. When replacing ground corn with crude glycerin at increasing levels in the diet of Texel lambs, a degree of finishing of 2.3 (2) was also observed (Rego et al., 2015). The values observed for finishing (mean of 3.66) indicate that the animals were in pattern 3 (carcasses with good fat coverage). For the conformation, the animals were also in pattern 3 (rectilinear carcasses with good muscle coverage).

The variables of meat quality, loin eye area, marbling and subcutaneous fat thickness did not differ between treatments (Table 3). The values observed for the loin eye area (Table 3) using the caliper method (postmortem) were 14.58 cm^2 for the oil diet and 16.77 cm^2 for the seeds diet, values which are close to those reported by other researchers, such as Rego et al. (2019), evaluating Texel lambs in finishing, and Benaglia et al. (2016), evaluating Ille de France lambs, who found mean values of 14.5 and 12.97 cm^2, respectively.

Table 3 - Measurements in the *longissimus lumborum* muscle of lambs finished on a diet with sunflower oil or seeds.

Variables*	Sunflower oil	Sunflower seeds	p-valor
LEA1 (cm^2)	12.95±3.32	13.70±2.78	0.68
LEA2 (cm^2)	14.58±1.98	16.77±2.19	0.09
SFT (mm)	1.41±0.19	1.38±0.27	0.81
MARBLING (1-10)	1.50±0.54	1.66±0.51	0.59
TL (%)	8.40±1.46	9.83±2.35	0.23
CL (%)	35.69±2.88	34.92±1.69	0.58
pH	5.77±0.25	5.63±0.19	0.27
L*	39.61±4.99	36.92±4.65	0.35
a*	14.44±1.94	14.23±2.64	0.88
b*	7.53±1.89	6.33±0.85	0.18
LWP (%)	79.34±5.83	76.05±5.56	0.34

LEA1: loin eye area via ultrasound; LEA2: loin eye area via caliper; SFT: subcutaneous fat thickness; TL: thawing losses; CL: cooking losses; L: luminosity; a*: red intensity; b*: yellow intensity; LWP: loss of water by pressure.
Source: Authors.

The average subcutaneous fat thickness between the groups was 1.39 mm, and it was similar between treatments. These values can be considered low and possibly are a consequence of the short confinement period and the slaughter at an early age of the animals, under 5 months old. This result is satisfactory, as carcasses of precocious lambs (slaughtered from 120 to 150 days of age) have less fat and meet the demands of the consumer market (Carvalho, et al., 2001). It is also noteworthy that the deposition of fat on the carcass (finishing) is always late compared to the deposition of muscle. According to Queiroz et al. (2015), carcasses with a thickness of 2 mm of fat show greater losses on cooling than carcasses with 3 or 4 mm of fat.

Senegalhe et al. (2014) evaluated the subcutaneous fat thickness related to the confinement time in lambs from the crossbreed Santa Inês x Dorper, and observed that the animals slaughtered at 108, 119, and 146 days of confinement presented 2.0, 3.0, and 4.0 mm of fat thickness.

Although the low values obtained for the thickness of subcutaneous fat, the degree of finishing of the carcasses was medium. Lima et al. (2013) studied the carcass of Texel lambs, fed diets with 60 and 80% concentrate, and obtained subcutaneous fat thickness values between 1.5 and 1.7 mm. In addition, these authors obtained carcasses with medium to superior conformation and degree of finishing. These results show that many times, although the fat cover is in the entire length of the carcass, thus guaranteeing a good degree of finishing and subjective notes above 3; this layer of fat can be thin in thickness, which is very common in lamb carcasses.

The presence of oil or sunflower seeds in the diets, both with a high level of concentrate (67%), did not influence the pH values of the meat ($p > 0.05$), with average values of 5.7 and 5.6 (Table 3), respectively. The pH values of lamb meat in this study corroborate the results of other authors (Alves, et al., 2014; Zeola, et al., 2002). In a study by Zeola et al. (2002), in which increasing levels of concentrate were used in the diet (30, 45, and 60%), no influence of this high level of concentrate on the pH values of meat was found. The results of Alves et al. (2014), in which mixed breed lambs were confined with fresh or roasted soybean with different levels of concentrate inclusion (50 and 80%), showed pH values within a range of 5.78 to 5.87.

The color of the meat (Table 3) is one of the most relevant aspects for the consumer, as it reflects the chemical status of the meat. The averages in the present study were 38.26, 14.33, and 6.93 for L*, a*, and b* components, respectively. These values are close to those obtained in other studies, such as that of Fernandes Junior et al. (2015), who observed values between 35.73 and 37.70 for L*, 13.95 and 15.33 for A*, and 10.15 and 10.9 for B*, in Santa Inês lambs.

Correlations were found between animal live weight at slaughter (LW) and carcass variables, demonstrating that live weight is positively correlated ($p < 0.05$), mainly with subjective variables, such as conformation (0.52), degree of carcass finishing (0.55), and AOL1, via ultrasound (0.69). It is important to note that the correlation between AOL1 (via *in vivo* ultrasound) and AOL2 measurements (made using a caliper on the carcass) was high and positive (0.56), similar to the correlation observed by Pinheiro et al. (2010), who found values of 0.54.

4. Final Considerations

The use of 5.5% sunflower seed, or 1.8% sunflower oil, as fat sources in diets of crossbred Santa Inês X Dorper lambs in finishing, guarantee the carcass and meat quality, producing carcasses with medium degree of finishing and conformation, low subcutaneous fat thickness and cold carcass yield above 45%.

Nevertheless, meat and carcass variables studied were similar in lambs fed with sunflower seed or oil, the use of seeds seem to have more advantages in animal feed, due to the ease in preparing and provide of the diet to the animals.

In addition, future studies can be carried out to evaluate the effects of including different levels of sunflower seed or oil in the lambs diet.

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