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Productive and economic efficiency in finishing reproductive cull ewe lambs with high concentrate diets

Eficiência produtiva e econômica na terminação de borregas de descarte reprodutivo com dietas de alto concentrado

GREGÓRIO¹, Odair Aparecido
<https://orcid.org/0000-0002-7527-9021>

ANDRADE¹, Marcos Rafael de
<https://orcid.org/0000-0001-5242-4225>

SANDINI¹, Itacir Eloi
<https://orcid.org/0000-0003-1105-1500>

SZYCHTA¹, Marina
<https://orcid.org/0009-0009-5285-4167>

FALBO^{1*}, Margarete Kimie
<https://orcid.org/0000-0003-4382-8337>

BRANQUINHO¹, Marcela Calciolari
<https://orcid.org/0009-0001-6438-2728>

¹ Universidade Estadual do Centro Oeste – UNICENTRO, Programa de Pós-graduação em Ciências Veterinárias, Câmpus Santa Cruz Rua Salvatore Renna – Padre Salvador, 875, CEP 85.015-430, Guarapuava/PR, Brasil

*Mail for correspondence: margaretefalbo@hotmail.com

ABSTRACT

This study aimed to evaluate the performance of reproductive culled lambs kept in confinement, through weight gain, carcass yield, and the state of non-carcass components using two high concentrate diets (90%). One diet was formulated on the property compared to commercially available concentrate. The cost-benefits of each diet were analyzed and compared. We used 24 Corriedale lambs, aged 180 days weighing an average of 28 ± 4 kg. The animals were randomly separated into two groups: the commercial concentrate group (CC) which received 0.4% and 4% of their live weight in Tifton hay and commercial concentrate, respectively, and the property concentrate group (CP) received hay and a high-concentrate diet produced on the property (using whole grain corn as a base), in the same proportions. The study was conducted, for a period of 55 days, along with ten days of adaptation, until they reached 40 ± 2 kg body weight (BW). Animals in the property concentrate group achieved a higher average daily gain (0.232 kg/day), but there was no significant difference in carcass yield between the groups. The weights of non-carcass components such as the liver, spleen, and kidneys with fat were higher in the concentrate group. The property concentrate group presented a net income of R\$ 0.40, while the animals that received the commercial concentrate presented a negative income of R\$ - 0.45, per day. Therefore, the use of a high-grain diet produced on the property under the conditions of this study allowed for better weight gain, and a better cost-benefit ratio.

Key words: carcass yield, feedlot, high grain diet, sheep farming

RESUMO

Este estudo teve como objetivo avaliar o desempenho de borregas de descarte reprodutivo em sistema de confinamento por meio do ganho de peso, rendimento de carcaça e de componentes não carcaça utilizando duas dietas de alto concentrado (90%), uma formulada na propriedade em comparação com concentrado comercial e analisar qual o melhor custo-benefício. Utilizou-se 24 borregas, da raça Corriedale, com idade de 180 dias, 28 ± 4 kg de peso vivo, confinadas. Os animais foram aleatoriamente separados em dois grupos: grupo Concentrado Comercial recebeu 0,4% do peso vivo de feno de tifton e 4% peso vivo do concentrado comercial, e o grupo Concentrado Propriedade recebeu feno e dieta de alto concentrado produzida na propriedade, tendo como base milho em grão inteiro, na mesma proporção, por um período de 55 dias, mais 10 dias de adaptação, quando atingiram 40 ± 2 kg PV. Os animais do grupo Concentrado Propriedade obtiveram ganho médio diário superior (0,232 kg/dia), porém não houve diferença significativa no rendimento de carcaça entre os grupos, e os componentes não carcaça como fígado, baço e rins com gordura obtiveram maiores pesos no grupo Concentrado propriedade. Quanto a avaliação econômica, o grupo Concentrado Propriedade apresentou receita líquida de R\$ 0,40 enquanto os animais que receberam o concentrado comercial apresentaram receita negativa de R\$ - 0,45, por dia. Desta forma, podemos concluir que o uso da dieta de alto grão produzida na propriedade, nas condições deste estudo, permitiu melhor ganho de peso, resultando em um melhor custo benefício.

Palavras-chave: confinamento, dieta alto grão, ovinocultura, rendimento de carcaça

INTRODUCTION

The state of Paraná has a sheep herd with 589,000 heads (IBGE, 2021), which are mainly concentrated in the Center-West and Center-South regions and are responsible for generating 96 million reais per year in Paraná (DERAL, 2023). To promote the sheep farming sector, it is necessary to maximize production and marketing by increasing farm performance, reducing seasonality, and achieving greater product uniformity with greater economic efficiency (Oliveira & Millen, 2014; Leite et al., 2020). Finishing lambs in an intensive system, such as confinement, is one of the alternatives that, combined with high-concentrate diets, can lead to faster weight gain and increased profitability, especially when grain prices are low. The economic viability of high-

concentrate diets are closely related to their components, production costs, and animal performance (Araújo Filho et al., 2022).

In addition to nutrition, another factor affecting animal performance is genetics. Several studies have evaluated the performance of lambs with specific genetics for meat production (Santos et al., 2018; Borges et al., 2013); however, there is little information available relating to the genetic fitness of reproductive cull lambs being raised on high-concentrate diets.

Therefore, this study aimed to analyze and compare the productive and economic efficiency of finishing confined reproductive cull lambs using two high-concentrate diets: one

formulated on the property and the other a commercially available concentrate.

MATERIALS AND METHODS

The experiment was conducted in the center-south region of the state of Paraná and was approved by the Animal Use Ethics Committee under protocol 011/2022. A total of 24 Corriedale lambs that were rejected for breeding were used. They were approximately 180 days old and had an average live weight (LW) of 28 ± 4 kg.

All animals were dewormed with 34% Nitroxinil, given subcutaneously, at $6.8 \text{ mg} \cdot \text{kg}^{-1}$ BW. They were then separated into two groups of 12, and further subdivided into four groups of three. These groups were allocated to 2 m² pens containing 1 and 1.20 m trough for hay and feed, respectively, a salt trough, and an automatic water fountain. Food was provided twice a day, at 7:30 am and 5 pm, with mineral salt and water ad libitum. One group received the commercial concentrate (CC) and the other group received a diet formulated on the property (CP) with the following ingredients: corn (80.3%), soybean meal (12.0%), calcitic limestone (1.6%), ammonium sulfate (2.0%), sodium bicarbonate (1.1%), vegetable oil (2.0%), and sugar (1.0%).

The experimental design consisted of randomized blocks (DBC), with two

treatments and 12 replications. During the adaptation period, the animals received 0.5% BW concentrated feed diet and 1% BW roughage (Tifton hay). The amount of each high-grain diet (DACs) was adjusted by 1.0% every three days, according to leftovers and based on the animals' performance. After 10 days of adaptation, the experiment began. Both groups received 0.4% BW roughage and 4% BW of their respective feeds (in a ratio of 90:10 concentrate to roughage). The nutritional compositions of the two diets are presented in Table 1. The leftover feed was weighed every morning and recorded to evaluate consumption and make the necessary corrections to the quantities supplied. Observations were also performed to identify animals with clinical signs of metabolic disorders such as apathy, anorexia, and marked distension of the rumen.

The animals were weighed every fortnight after 12 h of fasting to evaluate their performance and adjust their diet. The average daily weight gain (ADG) measurements started after the adaptation period. The ADG was calculated by subtracting the newest measurement from the previous measurement and then dividing the result by the number of days between the weigh-ins.

Table 1. Nutritional composition of the concentrate produced on the property and the commercially supplied concentrate for lambs finished in confinement

Parameter	Composition (%)	
	Proprietary	Commercial
Dry matter	87.5	87.5
Crude protein	13.8	14.0
Total digestible nutrients	83.6	84.0
Ethereal extract	6.5	3.2

Calcium	0.5	0.9
Phosphorus	0.3	0.4

The animals remained confined for a total period of 65 days, including the 10 days of adaptation, until they reached an approximate weight of 40 ± 2 kg. After this they were slaughtered in a slaughterhouse under the state inspection regime.

To determine the carcass yield, the weight of the hot carcass was divided by the live weight at slaughter, and the result was multiplied by 100 to obtain percentage values.

The non-carcass components (liver, lungs, heart, diaphragm, spleen, and kidneys with and without perirenal fat, head, and skin) were weighed. Blood was collected and weighed, and samples from each animal were packaged in tubes without anticoagulant to perform aspartate amino transferase (AST) tests to assess liver function. Urine was collected directly from the urinary bladder to assess pH.

To measure economic viability, the prices of ingredients, commercial feed,

and animal sales were collected at the end of the experimental period, and calculations were made based on the average daily gain, actual consumption, and input acquisition costs. Sale of animals (daily net income = (average daily gain x sale price of animals) – (effective daily consumption x price of inputs).

Statistical analysis was performed using the F-test at 5% error probability using the SISVAR[®] statistical program (version 5.6).

RESULTS AND DISCUSSION

The weight gain during the experimental period (55 d) is shown in Table 2. The animals in group CP showed greater weight gain in periods 2 and 3 of evaluation and was statistically significantly different from that of group CC.

Table 2. Average weights of lambs submitted to a high-concentrate diet, from group CC and CP during the adaptation (adapt.), the experimental period (P1, P2, and P3), hot carcass weight, and carcass yield

Group	Weight (kg)						Hot carcass weight	Carcass yield
	Adapt. phase	Initial weight 20/7/2022	P1 04/8/2022	P2 18/8/2022	P3 05/9/2022			
CC	28,4 ns	30,7 ns	33,4 ns	36,7 b	40,3 b	19,4 ns	48,2 ns	
CP	28,5	31,0	34,3	38,0 a	42,2 a	20,3	48,0	
Average	28,5	30,8	33,8	37,4	41,3	19,8	48,1	
*C.V. (%)	2,48	4,06	5,43	4,57	5,46	6,37	2,52	

Mean values with different letters in a column differ from each other in the F-test at 5%; values with ns: no significant difference in the F-test at 5%. * Coefficient of variation.

Carcass yield is directly correlated with breed, slaughter weight, age, and feeding

system (Cruz et al., 2022). Yousefi et al. (2019) evaluated the ideal carcass weight

in lambs, males and females, slaughtered at 150 days old a similar age as in our study and found the carcass yield of females to be 45.22%, corresponding closely to the yield achieved in this study (48%). We believe this is a good result, since cull lambs were evaluated with an initial weight of 28.5 kg, aged 180 days,

and without specific genetics for meat production.

No significant difference in ADG was observed between the periods evaluated (Table 3); however, when analyzing the total period with or without adaptation, group CP presented a higher ADG.

Table 3. Average daily gain (ADG) and coefficient of variation (CV%) in lambs in group CC and CP, during the adaptation phase, experimental period (P1, P2 and P3), and total period of the experiment with and without adaptation

Group	Average daily earnings (kg)					
	Adaptation phase	Period 1 04/08/22	Period 2 18/08/22	Period 3 05/09/22	With adaptation	No adaptation
CC	0.188 ns	0.183 ns	0.235 ns	0.202 ns	0.202 b	0.206 b
CP	0.208	0.217	0.269	0.231	0.232 a	0.238 a
Average	0.198	0.200	0.252	0.217	0.217	0.222
*C.V. (%)	42.74	34.33	28.60	35.54	14.93	16.20

Mean values with different letters in a column differ from each other in the F-test at 5%; values with ns: no significant difference in the F-test at 5%. * Coefficient of variation.

Leite et al. (2020) evaluated three high-grain diets based on whole grain corn in animals aged 180 days, without a defined breed, and on different proportions of concentrate: 100:0, 80:20, and 60:40. They did not find a significant difference in ADG (0.302, 0.254, and 0.259 kg/day). These values were similar to those found in this study (Table 4), specifically in group CP, which gained 0.232 kg/day, on a diet where the main basis of ACD was whole corn grain at a ratio of 90:10.

The intensification of production with the use of DAC, is an alternative form of meat production that is indicated mainly for meat breeds, as the response in terms of performance increases with an increase in the proportion of concentrate in the diet as previously observed in F1 Dorper × Santa Inês lambs (Barros et al., 2009).

Knowing that the concentrate accounted for 80% of the cost of CAD, the decision

regarding the ratio of concentrate to roughage in the diet needs to be analyzed involving on genetics and the cost of concentrate and roughage in addition to the current market prices.

Among the non-carcass components evaluated, there were statistically significant differences between the groups for fat content in the liver, spleen, and kidneys (Table 4). A higher viscera weight was observed in group CP and they presented a higher ADG during the periods evaluated, allowing us to infer that animals in Group CP had a higher metabolic rate and better utilized the dietary nutrients provided (Silva et al., 2019). The weights of the white viscera (rumen, abomasum, and intestine) were not evaluated due to slaughterhouse restrictions.

Evaluations carried out during the inspection at slaughter marked no changes in the liver of the animals between groups. This was confirmed by

the serum AST levels, which, despite the higher mean observed in group CC with a statistically significant difference (Table 5), remained within the reference values for the species (Varanis et al., 2021). The urinary pH was slightly more acidic in group CP, but within normal limits and with no significant difference (Table 5).

An unfavorable aspect of CADs are the metabolic changes that can occur due to the high intake of fermentable carbohydrates, causing subacute ruminal acidosis (SARA); therefore, buffers were included in both diets. In the diet of group CP, 1.1% sodium bicarbonate and 1.6% calcitic lime were used, whereas the commercial feed used for group CC contained magnesium and calcium, but

there are still many controversial opinions regarding the proportions used for increased performance (Kawas et al., 2005; Santra et al., 2003). Vicente (2022) used three levels of bicarbonate (1%, 2%, and 3%) in a 100% concentrated diet based on ground corn for confined lambs and found that 2% bicarbonate yielded better ADG results. Sen et al. (2006) used barley grains in a concentrate to roughage ratio of 75:25, and three levels of sodium bicarbonate (0.75%, 1.5%, and 2.25%) which all showed increased results when compared to the control group. However, there was no difference in the total weight of the animals fed on all three doses of bicarbonate.

Table 4. Non-carcass component weights of confined lambs submitted to diets high in concentrate to roughage ratio (90:10), from both group CC and CP

Diet	Viscera Weight (kg)										
	Blood	Liver	Lung	Heart	Diaphragm	Kidney		Spleen	Paw	Brain	Sheepskin
						with fat	fat-free				
CC	1.291 ns	0.725 b	0.686 ns	0.162 ns	0.145 ns	0.309 b	0.111 ns	0.084 b	1.455 a	2.130 ns	3.537 ns
CP	1.277	0.811 a	0,685	0.176	0.150	0.548 a	0.104	0.103 a	1.354 b	2.147	3.565
Average	1.284	0.768	0.685	0.169	0.148	0.429	0.108	0.094	1.404	2.139	3.551
C.V.(%)	9.35	10.81	9.92	20.22	22.42	34.22	12.19	8.60	9.35	8.88	8.96

Mean values with different letters in a column differ from each other in the F-test at 5%; values with ns: no significant difference in the F-test at 5%. *Coefficient of variation

Table 5. Mean serum aspartate amino transferase (AST) and urinary pH values for lambs confined on a high-concentrate diet, from groups CC and CP

Group	AST(UI/L)	Urine pH
CC	27.42 a	6.2 ns
CP	106.5 b	5.7
Average	192.46	6.0
*C.V.(%)	58.90	11.90

Mean values with different letters in a column differ from each other in the F-test at 5%; values with ns: no significant difference in the F-test at 5%. *Coefficient of variation.

Thus, the results observed in this study indicate that, up to the moment of slaughter, the DACs did not produce SARA in the animals, which implies that both diets, if used for 65 days (including the adaptation period), do not cause

SARA, which would impact performance and animal welfare.

The economic analysis (Table 6) showed that the animals in Group CP generated a net income of R\$ 0.40 per day, while the animals in group CC generated a loss of R\$ 0.45 per day.

Table 6. Average values of live weight (L.W), effective consumption in percentage, gross income, and income net, in reais (R\$) per day and per animal, in different periods, between groups CC and CP during the 55 days of confinement

Period	Live weight per animal (kg)		Effective consumption (% do L.W.)		Gross animal income (R\$ per day)		Animal net income (R\$ per day)	
	Group CC	Group CP	Group CC	Group CP	Group CC	Group CP	Group CC	Group CP
First	30.7	31.0	3.9	3.80	2.20	2.60	-0.47	0.33
Second	33.4	34.3	3.94	3.72	2.82	3.23	-0.08	0.77
Third	37.3	38.7	3.83	3.51	2.42	2.78	-0.72	0.15
Average	34.1	35.0	3.90	3.66	2.48	2.87	-0.45	0.40

Commercial concentrate cost = R\$2.20 per kg. Proprietary concentrate = R\$1.93 per kg. Selling price = R\$12.00 per kg of live weight.

Leite et al. (2020) analyzed the economic viability and performance of lambs with CAD present in different amounts of concentrates (100%, 80%, 60%) and found that all were viable. Bernardes et al. (2015) evaluated the feasibility of finishing Texel lambs in confinement with high-grain diets based on: black oats, white oats, and corn, and obtained in the highest profitability with corn grain (R\$ 0.69/lamb/day), corroborating the results of this study.

Brazil is a large producer of grains, and therefore also residues. Since the value of the energy unit for grains is lower in grain-producing regions, DAC is permitted to be used in feed. This enables the use of this dietary modality with productive and economic efficiency (Bernardes et al., 2015).

Regarding productive efficiency, both diets presented satisfactory performance and carcass yield, even when used in dual-purpose lambs, but the diet produced on the property had a better cost-benefit.

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