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Termination of lambs fed concentrate or pasture: performance and technical feasibility

Terminação de cordeiros alimentados com concentrado ou pastagem: desempenho e viabilidade técnica

Ana Gabriela de Freitas Saccol[1*]; Cleber Cassol Pires[2]; Ana Carolina Kohlrausch Klinger[3]; Luciana Pötter[2]; Liane Seibert[3]; Jusecléia Ferreira Lopes[3]; Fernando Luiz Ferreira de Quadros[2]; Silvio Teixeira da Costa[4]

Highlights:
Animals in the concentrate feed system (CFS) presented better feed conversion than animals in pasture feed system (PFS).
Animals from CFS took 77 days to reach 35kg whereas animals from PFS took 278 days.
The ruminal pH was higher, and more adequate, in the PFS group than the CFS.
The CFS lambs presented better quantitative characteristics, conformation and fat deposition.
PFS provided leaner and more muscular carcasses in lambs than CFS.

Abstract

A total of 28 uncastrated lambs, with 20kg of body mass (BM) were distributed into two different finishing systems where animals were fed either concentrate (CFS) or pasture (PFS) until 35 kg BM. The CFS diet consisted of 77.4% of corn grain; 20.2% soybean meal; 1.4% limestone and 1.0% sodium bicarbonate. The PFS diet consisted of both native pasture and ryegrass. The evaluated parameters were: dry matter intake (DMI), organic matter intake (OMI), crude protein intake (CPI), neutral detergent fiber intake (NDFI), feed conversion (FC), mean daily gain, days to reach 35kg BM, ruminal pH, in vivo biometric measurements, carcass composition, percentage of commercial cuts, pallet composition, and proportion of body components. The CFS animals had higher DMI, OMI, CPI and lower NDFI when compared to PFS. Also, animals feed CFS presented higher mean daily gain and better FC. Animals from CFS took 77 days to reach 35kg BM whereas animals from PFS took 278 days. The ruminal pH was higher, and more adequate, in the PFS group when compared to the CFS group. The CFS lambs presented better quantitative characteristics and conformation, and higher fat deposition. PFS lambs, on the other hand, provided leaner and more muscular carcasses. Thus, the termination of lambs without use of bulky feed is technically feasible and provides better zootechnical performance and carcass characteristics. However, the ruminal pH drop may compromise the system and must be observed.
Key words: High grain. Natural pasture. Ryegrass. Zootechnical performance. Lambs farming.

[1] Prof[a] Dr[a], Departamento de Zootecnia, Universidade Federal de Santa Maria, UFSM, Santa Maria, RS, Brasil. E-mail: agsaccol@hotmail.com
[2] Profs. Drs., Departamento de Zootecnia, UFSM, Santa Maria, RS, Brasil. E-mail: pirescleber@hotmail.com; potter.luciana@gmail.com; flfquadros@yahoo.com.br
[3] Dr[as] em Zootecnia, UFSM, Brasil, E-mail: aninhaklinger@hotmail.com.br; liane.seibert@hotmail.com; jussiferreiralopes@gmail.com
[4] Prof. Dr., Departamento de Morfologia, UFSM, Santa Maria, RS, Brasil. E-mail: silvio.teixeira.da.costa@gmail.com
[*] Author for correspondence

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Resumo

Conduziu-se ensaio biológico com 28 cordeiros não castrados, com massa corporal (MC) inicial de 20 kg, distribuídos em dois diferentes sistemas alimentares de terminação: concentrado (STC) ou pastagem (STP). A dieta do STC foi constituída de 77,4% de grãos de milho; 20,2% de farelo de soja; 1,4% de calcário e 1,0% de bicarbonato de sódio. A dieta do STP foi constituída de pastagem nativa e azevém. Os animais permaneceram nos sistemas até atingirem 35 kg de MC. Os parâmetros avaliados foram: consumo de matéria seca (CMS), consumo de matéria orgânica (CMO), consumo de proteína bruta (CPB), consumo de fibra em detergente neutro (CFDN), conversão alimentar (CA), ganho médio diário, dias para atingir 35kg, pH ruminal, medidas biométricas in vivo, composição de carcaça, porcentagem de cortes comerciais, composição da paleta e proporção de componentes corporais. Os animais do SFC apresentaram maior CMS, CMO, CPB e menor CFDN quando comparados com o STP. Ainda os animais do STC apresentaram maior ganho médio diário e melhor CA. Os animais do STC levaram 77 dias para atingir 35kg de MC, enquanto os animais do STP levaram 278 dias. O pH ruminal foi maior e mais adequado no STP que no STP. Os cordeiros do STC apresentaram melhores características quantitativas e conformação, e maior deposição de gordura. Por outro lado, o STP forneceu carcaças mais magras e mais musculosas. Assim, a terminação de cordeiros sem utilização de ração volumosa é tecnicamente viável e proporciona melhor desempenho zootécnico e características de carcaça. Entretanto, a queda do pH ruminal pode comprometer o sistema e deve ser observada.
Palavras-chave: Alto gão. Azevém. Pastagem natural. Desempenho zootécnico. Criação de cordeiros.

Introduction

Small ruminants, such as sheep, are very important in food production, since they transform bulky feed into protein of high biological value. These ruminants, therefore, play a significant role in mitigating hunger and sub nutrition in face of worldwide population growth. Traditionally, sheep are finished on pasture. In southern Brazil, the most common cultivated pasture is ryegrass.

However, when there is a shortage of good quality bulky feed and low-cost concentrated feed, non-bulking confinement for finishing lambs is an alternative. Studies have shown that sheep termination in confinement (without bulky feed) results in significant daily gain of body mass (Cirne et al., 2013). According to Motta el al. (2019), studies on carcass quality have been increasing in Brazil, and weaned lambs fed an exclusive concentrate diet presented differences in carcasses and conformation when compared to the other finishing systems.

The feeding system for lamb termination should take into account technical feasibility; commercialization; animal welfare; among others. As for the zootechnical viability, characteristics, such as: dry matter intake, mean daily gain, feed conversion, feed efficiency, days to reach slaughter mass and ruminal health must be observed. In case of pasture termination, the characteristics of the pasture should also be taken into account for the sustainability of the system (Boughalmi & Araba, 2016).

However, few studies have been conducted to compare the different lamb finishing systems (Poli et al., 2008). Due to the need of further investigation comparing different sheep termination systems, this study aimed to evaluate, on the basis of zootechnical and carcass parameters, the termination of lambs fed either concentrate or pasture.

Materials and Methods

Area description

The biological assays were carried out with the approval of Animal Ethics Committee (CEUA) file nº 013/2013 from Federal University of Santa Maria (UFSM) in Laboratory of sheep breeding - UFSM, Santa Maria, RS - Brazil. Santa Maria is located at 29º 41' of longitude, 53º48' W of latitude and 150m above sea level.

Animal management

Twenty-eight uncastrated Texel and Ile de France crossbreed lambs, with 20 kg of body mass (BM) were selected for the biological trial. The animals were identified, weighed and distributed in a completely randomized design in different feeding systems until they reached 35 kg BM.

Diets

The feeding systems used for finishing lambs were: exclusively concentrate (CFS) and rearing on both natural and ryegrass pastures (PFS).

Concentrate feeding system (CFS)

The CFS diet was calculated according to the National Research Council [NRC] (2007) to meet the nutritional requirements of lambs with initial BM of 20 kg, up to four months of age, with late maturity, ie: 0.59 kg DM (2, 97% BM); 3.7 g Ca (0.63%); 2.50 g P (0.42%); 0.39 kg of TDN (66.10%); 111g of crude protein (CP) (18.81%). Sodium bicarbonate ($NaHCO_3$) was also used in a total of 1% of the dry matter to regulate the ruminal pH. The diet consisted of 77.4% corn grain, 20.2% soybean meal, 1.4% calcitic limestone and 1.0% sodium bicarbonate. In this system, the animals were confined in individual fully covered stalls, with slatted floor, with approximately 2sqm of area with drinking troughs and feeders.

Pasture feeding system (PFS)

Natural pasture in a rotational grazing system were used in the PFS treatment with intervals of rest in degrees-day, determined as a function of the accumulated thermal sum. Four plots were used, and seven animals were placed in each plot. Instantaneous stock rate (kg BM / hectare) was determined based on the values of green material according to the BM necessary for each lamb to consume 70% of the fraction of leaves available at each initial grazing period, considering 4.5% disappearance rate (Heringer & Carvalho, 2002).

Botanical composition of natural pasture

In the natural pasture, 36 species from 10 different families were identified, among which stand out: Poaceae (17 species); Asteraceae or Compositeae (5 species); Apiaceae or Umbeliferae, (4 species); Convolvulaceae (2 species); Cyperaceae (2 species); Fabaceae or Leguminoseae, (2 species). The species that contributed most to the forage mass were Andropogon lateralis. Nees, with a 50.87% participation, followed by Paspalum notatum Liogier ex Flüggé, with 21,13%, Axonopus affinis Chase, with 18,13% and Fimbristylis diphylla (Retz.) Vahl, with a contribution of 3.11%. The plant species found in this study are compatible with those commonly found in the pampa biome (typical in Uruguay, South of Argentina and South of Brazil).

Forage in the natural pasture was estimated by visual estimates with double sampling (Haydock & Shaw, 1975). Eleven visual evaluations and three cuts were carried out. The cut material was separated into leaves, stem, dead material and others (Table 1).

Table 1
Composition of natural pasture in Santa Maria city, RS - Brazil

Date	FM (kg)	% Leaves	%DM in SOA	%FDN	%CP	%DMS	%TDN
15/10	4628	60.5	59,47	74,17	9,43	52,06	49,20
26/11	3788	58.3	55.01	64.02	8.41	56.88	54.25
02/01	3342	64.5	41.44	77.58	7.44	53.65	50.49
14/01	4741	63.5	59.91	74.89	7.32	60.67	57.26
24/01	8727	43.7	58.80	75.11	8.17	50.59	47.39
07/02	2762	39.5	56.08	81.21	7.48	46.14	43.43
21/02	2228	48.0	34.60	82.50	9.16	46.34	44.22
07/03	1375	48.2	54.51	76.92	12.1	61.89	58.10
18/03	4247	44.9	46.73	76.09	9.29	56.15	52.92
09/04	2802	66.1	48.97	81.05	9.66	44.69	42.92
05/06	2105	58.7	55.97	77.73	9.24	52.32	48.38

FM = Herbage mass per hectare. %Leaves = Perceptual of leaves in dry matter. %DM in SOA = % of dry matter in sample offered to animals. %NDF = Perceptual of neutral detergent fiber in dry matter. CB = Crude protein in dry matter. %DMS = Digestibility of dry matter. %TDN = Total digestive nutrients in dry matter.

Cultivated pasture

For ryegrass pasture, the grazing method adopted was continuous stocking. The adequacy of stocking to maintain the desired herbage mass was performed as proposed by Heringer and Carvalho (2002), using regulatory animals, aiming to maintain forage mass between 1400-1600 kg / ha dry matter.

Variables analyzed

Zootechnical performance

The analyzed variables were: dry matter intake (DMI), organic matter intake (OMI), crude protein (CPI), neutral detergent fiber intake (NDFI), mean daily gain, feed conversion to reach 35 kg and ruminal pH. In order to determine pasture consumption, total fecal collection was performed in all animals, using collector harness for five days, in three different periods for the period of natural pasture grazing and two different periods ryegrass pasture grazing. Animal mass and nutrient intake were recorded every 14 days. Ruminal fluid was collected in four different periods of the biological assay. The pH evaluation was measured at the same time, using a digital meter.

Carcass characteristics

The analysed variables were: in vivo biometric measurements; external components; non-carcass components; gastrointestinal tract; carcass mass, mass and yield of cuts (neck, palette, trim and leg); cover fat and marbling; and loin eye area.

Carcasses were weighed immediately after slaughter to determine the warm carcass mass and the warm carcass yield, and afterwards were conditioned in a forced-air refrigeration chamber at 4ºC for 24 hours. After cooling, the carcasses were again weighed to obtain the cold carcass mass, and the cold carcass yield and the cooling break. For this, the following formulas were used:

$$Warm\ cascass\ Yield = warm\ carcass\ mass\,\frac{100}{BM}$$

$$Cold\ carcass\ yield = cold\ carcass\ mass\,\frac{100}{BM}$$

$$Cooling\ break = 100 - \left(\frac{cold\ carcass\ mass}{warm\ carcass\ mass}\right)100$$

The carcass was cross-sectioned between the 12th and 13th ribs and the Longissimus dorsi muscle exposed in order to measure fat thickness using a pachymeter (Cañeque & Sañudo, 2005). Marbling intramuscular fat was visually determined and a score from a scale of 1 to 5, was attributed in which 1.0 = nonexistent marbling and 5.0 = excessive marbling (Osório & Osório, 2003).

The loin eye area (LEA) expressed was determined by exposing the Longissimus dorsi muscle and tracing the muscle contour on paper, and, thus, determining the area of the figure.

Statistical analysis

Data were submitted to analysis of variance and F test at the 5% level of significance. In addition to the statistical analysis comparing the CFS and PFS systems, the two pastures within the PFS were analysed by the same procedure.

Ruminal pH was analysed as a measurement repeated in time, considering the fixed effect of the feeding system, day of evaluation and its interactions, as well as the random effects of the residue of animals from each system.

Results

Nutrient intake

There was a difference for nutrient intake among the systems, since the CFS animals had higher DMI, OMI, PBI and lower NDFI regardless of being expressed as absolute values or percentage of BM (Table 2). However, both systems presented nutrient intake within the requirements of the category used in this study (with the exception of NDF in CFS).

Table 2
Nutrient intake by lambs in two fed systems

0	CFS	PFS	P-Value	SEM
Intake	kg			
Dry matter	0.783	0.610	0.0223	0.042
Organic Mater	0.749	0.555	0.0176	0.045
Crude Protein	0.137	0.094	0.0073	0.008
Neutral detergent fiber	0.137	0.395	0.0001	0.015
	% of body mass			
Dry matter	2.872	2.401	0.0212	0.114
Organic Mater	2.745	2.194	0.0126	0.116
Crude Protein	0.501	0.344	0.0047	0.025
Neutral detergent fiber	0.502	1.615	<0.0001	0.0538
	in100 kg of Dry Matter			
Neutral detergent fiber	17.630	64.847	<0.0001	1.429

CFS = Concentrate fed system; PFS = Pasture fed system. SEM= Standard error of the mean.

To better understand the intake results in PFS, it is necessary to separate the period in which the animals were submitted to either natural or ryegrass pasture which were used during different periods and presented different bromatological compositions. It was observed that the DMI, OMI, CPI, NDFI were different in the natural pasture and ryegrass pasture, with the best values being obtained in the ryegrass pasture.

Mass gain and days to reach 35kg

There was no difference between the feeding systems for initial body mass, final body mass and body mass after fasting (Table 3), a fact explained by the criterion used for the end of the biological test, which is, BM of 35 kg. The number of days needed to reach BM of 35 kg was 77 days for CFS and 278 days for PFS. Still, in pasture termination, the natural pasture provided mass maintenance of lambs weaned in the spring and summer. The high NDFI and low CPI in this period may explain the observed performance.

Table 3
Performance and mass evolution of lambs in two fed systems

	Fed system			
	CFS	PFS	P- Value	SEM
Initial Mass	20.8	21.1	0.5105	1.576
Final Mass	36.8	37.2	0.2657	2.003
Days for final mass	77	278	<0.0001	18.897
Daily mass gain	0.208	0.058	<0.0001	0.035
Fed convertion	3.922	10.818	0.0017	0.814
Alimentar eficiency	0.265	0.094	0.0175	0.045

CFS = Concentrate fed system; PFS = Pasture fed system. SEM= Standard error of the mean.

Ruminal pH

There was no interaction between the termination system and the day of pH measurement, the lowest pH being observed 43 days after the start of the biological assay. The ruminal pH of the CFS animals was below the normal physiological value and a difference was observed between the feeding systems (Table 4).

Table 4
Ruminal pH of lambs in two fed systems after 9, 26, 43 and 60 days

	Fed systems				
	CFC	PFS	Mean	P-value	SEM
pH 9 days	5.58	6.53	6.27^{ab}		0.072
pH 26 days	5.59	6.74	6.29^{ab}	0.0065	0.065
pH 43 days	5.37	6.64	6.22^{b}		0.075
pH 60 days	5.71	6.94	6.48^{a}		0.068
	5.58 ± 0.07	6.71±0.05		<0.0001	

CFS = concentrate fed system; PFS = Pasture fed system. SEM = Standard error of the mean.

Biometric and morphometric measurements

CFS animals presented better conformation than PFS animals, and those presented higher values for body condition with the same BM. In relation to the in vivo measurements (body length, anterior height, posterior height and thoracic perimeter) and in the morphometric measurements of the carcass (internal carcass length, leg length, chest depth, leg width and leg depth) systems did not differ (Table 5). CFS animals presented higher warm carcass mass, cold carcass mass and warm carcass yield (Table 6).

Table 5
In vivo and morphometric measurements of the carcass of lambs finished in two fed systems

	Fed system			
	CFS	PFS	P-Value	SEM
	In vivo			
Corporal length (cm)	66.4	64.2	0.38	5.36
Anterior height (cm)	59.1	58.9	0.93	3.93
Posterior height (cm)	54.8	55.3	0.59	2.01
Thoracic perimeter (cm)	89.8	91.0	0.71	7.10
kg/cm	0.51	0.54	0.30	0.06
	In carcass			
Internal carcass length (cm)	55.1	55.7	0.35	1.30
Leg length (cm)	35.3	35.5	0.89	2.49
Chest depth (cm)	24.6	24.7	0.76	1.07
Leg width (cm)	10.5	10.6	0.73	0.96
Leg Depth (cm)	15.9	15.3	0.37	1.55

CFS = concentrate fed system; PFS = Pasture fed system. SEM = Standard error of the mean.

Carcass conformation of the and tissue composition

Carcass conformation was better in the CFS group, which presented higher fat status and fat thickness than the PFS group (Table 6). Whereas, yield of the cuts and LEA did not present any difference between the feeding systems (Table 7). From the tissue composition obtained through the dissection of the shoulder, a higher percentage of internal fat and total fat were observed in the CFS group and a higher proportion of muscle and bone were observed for the PFS group (Table 7).

Non-carcass components

The non-carcass components and external body components accounted for 44.98% and 51.99% of TBM in CFS and PFS, respectively. The skin was the component with the highest percentage, 14.88% and 18.10%, in CFS and PFS, respectively, when compared to the other external and non-carcass components, followed by blood, head and feet. Of these, only the head presented a difference between the feeding systems, since the animals finished in the grazing system took longer to reach the slaughter mass (35 kg), fact which may explain the higher head mass (Table 8).

When expressed as a percentage of live corporal mass, the components that presented difference between systems were: lung; heart; liver; internal fat; rumen; reticulum; omasum and abomasum. The CFS group also had a higher percentage of internal fat in relation to TBM. There was a difference in rumen size reticulum, omasum and abomasum greater mass for all stomach compartments. Regarding the small intestine, there was no difference between the feeding systems (Table 8).

Table 6
Carcass characteristics of lambs finished in two fed systems

CFS	Sistema de alimentação			
	PFS		P-Value	SEM
Warm carcass mass (kg)	17,0	15,1	0,0209	1,48
Cold carcass yield (kg)	16,5	14,5	0,0155	1,47
Warm carcass yield (%)	51,0	44,1	0,0008	3,12
Cold carcass yield (%)	49,5	42,4	0,0005	3,00
True yield (%)	52,6	45,2	0,0001	2,59
Cooling break (%)	2,8	3,8	0,2420	1,76
$\frac{\text{Cold carcass mass}}{\text{carcass length}}$ (kg/cm)	0,30	0,26	0,0063	0,02
Gastrointestinal content (% CM)	11,1	15,6	0,0119	2,26
Gastrointestinal content (kg)	3,4	5,00	0,0006	0,70
Gastrointestinal content (% of BM)	10,2	14,6	0,0009	2,03
Neck (%)	3,4	2,8	0,0368	0,55
Shoulder (%)	3,5	2,6	0,0019	0,46
Ribs (%)	1,5	0,7	0,0120	0,63
Round (%)	2,8	2,1	0,0205	0,56

CFS = Concentrate fed system; PFS = Pasture fed system. SEM = Standard error of the mean.

Table 7
Shoulder composition of lambs finished in two fed systems

	Fed systems			
	CFS	PFS	P-Value	SEM
Pre scapular fat (%)	3.20	3.10	0.93	1.33
External fat (%)	9.90	7.80	0.14	2.89
Internal fat (%)	12.00	7.50	0.006	2.80
Total fat (%)	25.10	18.40	<0.001	2.79
Muscle (%)	52.70	56.00	0.03	2.90
Bone (%)	19.40	23.10	0.02	2.98
Others	2.80	2.50	0.38	0.82
Muscle/Total fat	2.10	3.10	0.001	0.48
Muscle/Bones	2.80	2.40	0.08	0.44

CFS = Concentrate fed system; PFS = Pasture fed system. SEM = Standard error of the mean.

Table 8
Non-carcass and external components of lambs finished in two fed systems

	Fed system			
	CFS	PFS	P- Value	SEM
Empty body mass (kg)	30.90	31.40	0.67	2.23
Warm carcass mass (% of BM)	55.02	48.01	<0.0001	2.69
	External corporal components (% of empty body mass)			
Head	4.50	5.14	0.01	0.47
Patas	2.87	3.09	0.08	0.26
Skin	14.88	18.10	0.05	3.24
	Non-carcass components (% of empty body mass)			
Blood	5.12	5.88	0.19	0.90
Tongue	0.31	0.33	0.56	0.07
Esophagus	0.15	0.18	0.10	0.04
Trachea	0.31	0.33	0.73	0.07
Lung	1.22	1.47	0.008	0.16
Diaphragm	0.65	0.55	0.05	0.10
Heart	0.58	0.67	0.04	0.08
Heart fat	0.18	0.15	0.36	0.09
Liver	2.16	2.53	0.02	0.30
Pancreas	0.23	0.24	0.92	0.15
Thymus	0.51	0.38	0.06	0.14
Kidneys	0.39	0.39	0.91	0.05
Kidneys fat	0.35	0.24	0.12	0.15
Spleen	0.21	0.26	0.10	0.06
Internal fat	1.85	1.02	0.007	0.54
Bladder	0.08	0.05	0.09	0.03
Gallbladder	0.02	0.02	0.18	0.00
Penis	0.44	0.41	0.83	0.34
Testicles	0.99	0.86	0.38	0.32
Rumen	2.22	2.82	0.002	0.31
Reticle	0.30	0.49	0.0003	0.08
Omaso	0.16	0.35	0.0005	0.08
Abomaso	0.57	1.08	<0.0001	0.13
Small intestine	2.14	2.82	0.15	0.98
Large intestine	1.59	2.05	0.08	0.52

CFS = Concentrate fed system; PFS = Pasture fed system. SEM = Standard error of the mean.

Discussion

The aim of this study was to compare two feeding systems for finishing lambs: concentrate (CFS) and pasture (PFS). After the biological assays we were able to conclude based on zootechnical and carcass parameters, that the CFS system was more efficient. NDFI, for example, was higher in PFS, which explains the lower DMI. As the PFS diet presented higher percentage of NDFI, feed remained longer in the rumen, which limited feed intake as a function of physical capacity. The DMI (% BM) was lower in lambs from the PFS system, however, it varied according to the type of pasture offered – natural or ryegrass (Sormunen-Cristian, 2013).

The low DMI observed in lambs from natural pasture can be explained by its high NDF content, which probably limited the DMI. When diets with high NDF are consumed, intake occurs until maximum gastrointestinal tract capacity is reached (Forbes, 1995). There was a higher nutrient intake in ryegrass pasture, explained by the higher CP content in the pasture. CPI ranged from 42 to 288g/day, with lower intake observed during the period lambs were grazing on natural pasture.

Comparing the average percentage of CP and NDT obtained in the bromatological analysis of the leaves and grazing simulation of natural pasture and ryegrass pasture with nutritional requirements (NRC, 2007), we observed that natural pasture does not meet the nutritional requirements of lambs from 20 kg of BM to mean daily gain of 100g, whereas, ryegrass pasture provides nutrients for mean daily gain of 300g.

However, the elevation of DMI in CFS led to a decrease in ruminal pH. In this sense, when ruminal pH is low, feed intake decreases. The decrease in feed intake possibly works as an internal mechanism that attempts to limit excessive fermentation, which consequently restores pH to "comfortable" levels. Once the pH returns to adequate levels (between 6 and 7), the animal starts eating again, which causes a further production of acids in the rumen, causing the whole cycle to repeat itself (Schwartzkopf-Genswein et al., 2003).

The number of days needed for lambs to reach BM of 35kg was 77 days for the CFS and 278 days for the PFS. This result should be emphasized, since there is a need for regular supply of lamb meat on the market throughout the year. Thus, our results indicate that CFS is the most suitable system. Transposing this data to the reality of the region where this study was conducted (Southern Brazil), where lambing occurs in August and September, the CFS system provides higher daily mean gain and consequently better lamb supply for the period with the highest commercial demand (from December to January). On the other hand, this is also, traditionally, the period of greatest supply. Conversely, PFS provides lamb meat in the period from June to August, when there is less supply in the market. Thus, it is clear that there is a possibility of offering lamb meat at different times of the year. However, it is important to characterize the meat produced in each of these systems.

The CFS group was superior to the PFS in R. C. L. F. Silva and Pires (2000), show that the highest carcass yields are found in animals slaughtered at weaning, considering that gastrointestinal tract presents faster growth rate after weaning. In our study, this occurred because the PFS animals took 201 days longer to reach slaughter mass than those from CFS and also presented a higher percentage in relation to BM of head, lung, heart, liver, rumen, reticulum, omasum and abomasum, similar to what was described by Budimir, Trombetta, Toderi and D'ottavio (2018).

Fatty status values, 3.5 and 2.6 for CFS and PFS lambs, respectively, are considered slightly fat and slightly thin, respectively. Still, the animals from the CFS system presented fat thickness of 1.5mm, whereas lambs from the PFS system presented fat thickness of 0.7 mm. The values found in both systems are higher than the recommended minimum for lamb carcasses which, according to A. G. Silva (2001), should be 0.3 mm. The muscle/fat ratio, which differed between feeding systems, showed that the PFS animals obtained a higher amount of muscle than total fat, providing leanner carcasses and a higher percentage of muscle.

The carcass from animals in the PFS system meets the guidelines issued by ANVISA in June 2014, in the Guide to Good Nutritional Practices

(BPN) in collective restaurants. This document states that the meat is the main fat source in food and in order to reduce people's fat intake, it is suggested, that among other measures, that restaurants chose leaner meats (Brasil, 2014a).

Regarding internal fat (omental and mesenteric fat), the CFS lambs had a higher percentage. Diets with a higher level of concentrate increase the concentration of propionic acid in the rumen and decrease the acetate / propionate ratio, resulting in greater availability of energy in the form of glucose, which favors lipogenesis and thus the visceral fat deposition (Kozloski et al., 2006). In addition, the CFS system provided higher daily energy intake and lower energy expenditure of confined lambs.

Moreno et al. (2001) states that the factors influencing the non-carcass components of lambs are varied and contradictory, making it necessary to carry out more studies in order to encourage their use and add value to lamb meat production systems. However, it is important to consider the great diversity of ways in which the results from such studies are expressed and published. Some authors express their results in kg or percentage of BM, others in percentage of TBM, which makes it difficult to compare results from different studies. In this sense, it is suggested that the subsequent studies publish the necessary information for the conversion of values and possible comparisons.

The organs and viscera, in comparison to other parts of the animal's body, presented different growth rates and were influenced mainly by the chemical composition of the diet and its energy level. Camilo et al. (2012) observed that the increase of the metabolizable energy levels of the rations influences the mass and yield of the internal organs, viscera and fat of Morada Nova sheep. In addition, Moreno et al. (2001), studying the yield of the non-carcass components of lambs fed corn silage or sugar cane and two levels of concentrate, concluded that the type of feed had greater influence on the proportions of the organs responsible for digestion and absorption of nutrients.

It becomes evident that when the evaluation is made based on production aspects, the CFS system is superior, as it presents greater mass gain, better conversion values and food efficiency, requiring a smaller number of days to reach the slaughter mass. This system presents better values in body condition, higher warm carcass (mass and yield) and cold carcass (mass and yield) in the in vivo evaluation. In relation to the carcass evaluations, the CFS termination presents better conformation, greater fat thickness and marbling. In the tissue composition of the shoulder, it is superior in both internal and total fat.

The food guide for the Brazilian population presents as one of its principles that adequate and healthy food derives from a socially and environmentally sustainable food system. Food recommendations should take into account the impact of food production and distribution on social justice and environmental integrity (Brasil, 2014b).

Ruminant animals are characterized by transforming pasture into protein of high biological value. These are the animals that can use the biodiversity of native species and convert it into food production. However, this activity, for economic reasons, has been replaced by crops or forests (Galvani et al., 2018).

This study did not quantify parameters related to environmental sustainability. However, it presents an important contribution related to production and quality aspects of the meat produced in confinement be it from concentrate or pasture diet, which can serve as criteria for establishing quality markers and the valorisation of meat from grazing animals.

The natural pasture does not meet the nutritional requirements of lambs. The association of natural pasture with the ryegrass pasture, optimizes the termination of very young lambs. The PFS system is characterized by being less dependent on commercial feedstock and by maintaining biodiversity and, consequently, greater environmental sustainability.

It noteworthy that the feeding systems used in this study attend niche markets and, thus, should be considered and valued. The CFS system presents advantages in relation to the PFS system regarding both productive and economic viability, as well as, management aspects. However, it is dependent on the purchase of concentrate, which may affect the sustainability of the system.

Conclusion

Based on zootechnical performance data and time to reach 35kg BM it can be concluded that the CFS is viable for finishing of lambs, as long as ruminal health is maintained. However, PFS provides leaner carcasses and higher percentage of muscle, which seems to be better from a commercial point of view.

It was also concluded that the choice of the system should take into account the period of the year in which the meat will be sold. The PFS system allows lambs to be finished on ryegrass pastures at a period of shorter meat supply (July and August), while the finishing in confinement takes place around 70 days after weaning.

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