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Fresh or dehydrated spineless cactus in diets for lambs

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ABSTRACT. The objective was to evaluate the effect of partial or total replacement of Tifton 85 hay with fresh or dehydrated spineless cactus on performance and body weight components of sheep. Thirty hair lambs, with 19 kg ± 0.35 kg initial weight, were randomly divided into five treatments, namely: Tifton 85 Hay (HA); Tifton 85 Hay + fresh spineless cactus (HAFC); Tifton 85 Hay + dehydrated spineless cactus (HADC); fresh spineless cactus (FC); dehydrated spineless cactus (DC). In addition to the spineless cactus and hay, the complete mixture contained soybean meal, mineral salt and limestone in all treatments. Animals were confined for 75 days and then slaughtered. The weight of body components was recorded. Dry matter intake, total digestible nutrients intake and voluntary water intake were higher ($p < 0.05$) for the DC and HADC treatments. The average daily gain was 118 g day^{-1} and body weight at slaughter of 25.8 kg were not influenced ($p > 0.05$) by treatments. The cold carcass weight, rib eye area, weight and yield of the skin, liver, kidney and large intestine were higher ($p < 0.05$) for the DC and HADC treatments. Partial or total replacement of Tifton 85 hay with fresh or dehydrated spineless cactus, in complete diets for sheep, increases the weight of the cold carcass and non-carcass components.

Keywords: cacti, body weight components, cactus meal.

Palma forrageira *in natura* ou desidratada na dieta de ovinos

RESUMO. Objetivou-se avaliar o efeito da substituição parcial ou total do feno de Tifton 85 por palma forrageira *in natura* ou desidratada sobre o desempenho e componentes do peso corporal de ovinos. Foram distribuídos aleatoriamente 30 cordeiros deslanados, com peso vivo inicial de 19 kg ± 0,35 kg, em cinco tratamentos, a saber: feno de Tifton 85 (FE); feno de Tifton 85 + palma *in natura* (FEPA); feno de Tifton 85 + palma desidratada (FEPD); palma *in natura* (PA); palma desidratada (PD). Além da palma e feno ofertou-se, na forma de mistura completa, farelo de soja, sal mineral e calcário em todos os tratamentos. Os animais foram mantidos confinados durante 75 dias; decorridos esse período foram abatidos e tiveram os pesos dos componentes corporais registrados. O consumo de matéria seca, nutrientes digestíveis totais e ingestão voluntária de água foram maiores ($p < 0,05$) para os tratamentos PD e FEPD. O ganho médio diário foi de 118 g dia^{-1} e o peso corporal ao abate de 25,8 kg e não foram influenciados ($p > 0,05$) pelos tratamentos. O peso de carcaça fria e área de olho de lombo foram menores ($p < 0,05$) para dieta FE. A substituição parcial ou total do feno de Tifton 85 por palma forrageira (*in natura* ou desidratada) melhora o desempenho e as características de carcaça de ovinos.

Palavras-chave: cactácea, componentes do peso corporal, farelo de palma.

Introduction

Production of small ruminants in the Brazilian semi-arid region is based on the vegetation of the caatinga biome as a staple food. In this ecosystem, plants are adapted to seasonal changes in rainfall and have developed mechanisms to reduce water shortage, such as leaf shedding. Thus, during the dry season, the amount of grazable biomass is dramatically reduced and the flocks are affected by forage scarcity (Santos, Lira et al., 2010; Pereira Filho, Silva, & Cézar, 2013).

Some alternatives have been suggested to minimize the impact of variation in forage allowance on flocks, namely, forage conservation and use of forage adapted to semi-arid areas (Ferreira, Silva, Bispo, & Azevedo, 2009). The spineless cactus occupies a prominent position due to its productivity, nutritional value and distribution in the Brazilian semi-arid. Batista et al. (2003) reported 12% average dry matter (DM); 81.4% organic matter (OM), 6.2% crude protein (CP), 2.1% ether extract (EE), 26.9% neutral detergent fiber (NDF), 16% acid detergent fiber (ADF), 66.2% total digestible nutrients (TDN) for spineless cacti of the genera *Opuntia* and *Nopalea*.

Spineless cactus can preserve its nutritional value over a long period; it can be harvested or left in the field for up to four years without impairing its quality and yield. However, the emergence of pests, such as carmine cochineal (*Dactylopius* sp.), can demand harvesting as soon as possible in order to help to control or prevent the spread of insects. This surplus, if kept moist, is perishable and has a life of 16 days (Santos et al., 1998). Another aspect to be mentioned is transport. Currently, there are farmers who grow spineless cactus for marketing and logistics for commercialization represents an obstacle due to great weight of the material and low nutrient density. Therefore, dehydration of spineless cactus can help control cochineal and reduce freight costs per unit of dry matter shipped.

Some studies have been conducted to investigate the effects of dehydrated spineless cactus or meal replacing corn in the diet for sheep and the results indicate that, at high levels, dehydrated spineless cactus results in reduced intake, digestibility, performance and carcass characteristics of sheep (Véras, Ferreira, Cavalcanti et al., 2005; Véras, Ferreira, Véras et al., 2005; Santos et al., 2011). Nonetheless, the dehydrated spineless cactus has not been tested when combined with a dehydrated forage, like hay, for example.

The replacement of Tifton hay with spineless cactus (fresh or dehdyrated) also reduces the neutral detergent fiber content in diets and enables the analysis of the effect of low fiber diets on sheep performance.

Thus, the goal was to evaluate the effect of partial or total replacement of Tifton 85 hay with fresh or dehydrated spineless cactus on performance and body weight components of sheep.

Material and methods

Thirty hair intact lambs, without defined breed, with 19 kg ± 0.35 kg initial weight, 240 days initial age, were kept in individual folds of 2.0 x 1.1 m, equipped with wooden trough at the ground level and bucket drinker, cement floor and wooden divisions.

The experimental diets were prepared to provide a daily weight gain of 150 g day-1. Diets consisted of Tifton 85 hay mixed with the concentrate (HA), Tifton 85 hay + dehydrated spineless cactus mixed with the concentrate (HADC), Tifton 85 hay + fresh spineless cactus mixed with the concentrate (HAFC), dehydrated spineless cactus mixed with the concentrate (DC) and fresh spineless cactus mixed with the concentrate (FC). We used spineless cactus (*Nopalea cochenillifera Salm-Dyck*), fresh and dehydrated, Tifton 85 grass hay (*Cynodon* spp.), soybean meal (*Glycine max* (L.), urea, mineral salt and limestone. It was used urea with ammonium sulfate at a ratio of 9: 1 (Table 1 and 2).

Table 1. Chemical composition, in percentage of dry matter, price of ingredients of the experimental diets.

	Fresh spineless cactus	Dehydrated spineless cactus	Tifton 85 hay	Soybean meal	Urea	Limestone	Mineral Mix
Dry matter (%)	7.3	82.2	84.5	80.6	98.0	99.0	99.0
Organic matter (%)	81.5	80.8	92.6	84.6	-	-	-
Crude protein (%)	8.0	8.0	10.4	47.6	281.0	-	-
Ether extract (%)	1.0	0.9	0.7	0.7	-	-	-
NDF (%)[1]	27.2	25.1	76.7	28.9	-	-	-
NFC (%)[1]	45.4	46.7	4.7	7.4	-	-	-
Mineral matter (%)	18.5	19.2	7.4	15.3	-	-	-
Ca (%)	2.3	2.3	0.4	0.3	-	37.5	12.0
P (%)	0.2	0.2	0.2	0.6	-	-	9.0

[1]NDF: neutral detergent fiber; NFC: non-fiber carbohydrates.

Source: elaborated by author.

Table 2. Participation of ingredients, chemical composition, in percentage of dry matter, and price of the experimental diets.

Ingredient	Diet (%)				
	HA	HADC	HAFC	DC	FC
Tifton 85 hay	75.5	37.7	37.7	-	-
Fresh spineless cactus	-	-	37.17	-	74.2
Dehydrated spineless cactus	-	37.17	-	74.2	-
Soybean meal	23.0	23.0	23.0	23.0	23.0
Urea + Ammonium sulfate	-	0.63	0.63	1.3	1.3
Limestone	1.0	1.0	1.0	1.0	1.0
Mineral	0.50	0.50	0.50	0.50	0.50
Total	100.0	100.0	100.0	100.0	100.0
Chemical composition (%)					
Dry matter	88.1	88.2	22.6	88.2	12.9
Crude protein	16.4	16.3	16.3	16.3	16.3
Total digestible nutrients	67.7	70.2	79.8	75.9	81.8
Neutral detergent fiber	62.1	44.5	44.5	26.9	26.9
Non-fiber carbohydrates	10.3	31.6	31.6	52.9	52.9
Ether extract	1.6	1.7	1.7	1.8	1.8
Ca	0.83	1.5	1.5	2.2	2.2
P	0.31	0.33	0.33	0.35	0.35

Source: elaborated by author.

Spineless cactus was acquired in the region of Lagoa de Itaenga, State of Pernambuco, and stored in the sheep shed. For the manufacture of dehydrated spineless cactus, fresh spineless cactus was daily chopped with a knife, placed on plastic canvas on the ground and exposed to the sun for 24 hours. After, the partially dehydrated material was triturated in a mincer (JK 500 TRAPP®) and taken to be dried at 60°C for 24 hours in an oven with forced air circulation. Subsequently, dehydrated palm was crushed in shredder (ES 500-550 TRAPP®) to achieve homogeneous particle size (3-5 cm), facilitating the mixture with the other ingredients of the feed.

The experimental period lasted 75 days, 15 for adaptation of animals. During the adaptation period, all animals received a diet composed by Tifton hay as roughage. During the experimental period, feeding was performed in the form of complete feed, at 08h00min and 15h00min, allowing leftovers around 10%. The amounts of food supplied and leftovers were weighed daily and intake was adjusted every other day. Water was given *ad libitum*, and its intake was measured every 15 days, with corrections for evaporation.

The voluntary intake of dry matter and different nutrients was calculated by the difference between the amounts offered and refused. In the last experimental week, the digestibility of dry matter and nutrients was evaluated for 72 hours, using total feces collection with collection bags.

During the experimental period, samples of foods and diet provided, and the leftovers were taken weekly to calculate the consumption of nutrients. In the period for determining the digestibility, foods, leftovers and feces were daily sampled and immediately dried in an oven with forced air circulation at 55°C, ground and packed in plastic bags previously identified and stored at -20°C for subsequent determination of chemical composition.

Determinations were made for dry matter (DM), mineral matter (MM), crude protein (CP), ether extract (EE), neutral detergent fiber (NDF), acid detergent fiber (ADF), total carbohydrates (CHOT) and non-fiber carbohydrates (NFC). To estimate the total digestible nutrients (TDN), we used the following equation TDN = CPD + EED*2.25 + NFCD +NDFcpD, in which CPD = (ingested CP - feces CP), EED = (ingested EE - feces EE), NFCD = (NFC ingested - NFC feces) and NDFcpD = (ingested NDFcp - feces NDFcp) (Silva & Queiroz, 2002).

At the end of the experiment, animals were weighed to obtain the final body weight (BW), and after fasting for 16 hours, were reweighed to obtain the slaughter weight (SW). After weighing, animals were stunned by cerebral concussion and exsanguinated. Then, animals were skinned; paws and head were removed. Evisceration was performed to obtain the whole carcass and to record hot carcass weight with kidney and pelvic-renal fat (HCWkf). In this process, we weighed blood, carcass, skin, paws and head. They were considered as non-carcass components: heart, liver, kidneys, rumen, reticulum, omasum, abomasum, small intestine, large intestine, blood and skin.

Subsequently, the carcasses were taken to the cold room at temperatures between 2 and 4°C for 24 hours, to be cooled with the tarsal-metatarsal joints spaced apart by the hooks. At the end of this period, the weight of the cold carcass with kidneys and fat (CCWkf) was written down, thus allowing the calculation of cooling losses (CL = [HCWkf-CCWkf]*100). Kidneys and pelvic-renal fat of the cold carcass were removed and weighed, whose values were subtracted from HCWkf and CCWkf to determine, respectively, the hot (HCW) and cold (CCW) carcass weight and cold carcass yield (CCY (%) CCW / HCW x 100) (Cezar & Sousa, 2007).

After the removal of tails, carcasses were divided lengthwise and the left half-carcass was sectioned into for anatomical parts (leg, shoulder, loin, ribs). The individual weight of each cut consisting of the cuts made in the left half carcass was recorded to calculate the ratio in relation to the sum of the half carcass, thus obtaining the commercial yield of the carcass cut. The loin eye area was measured in the in the *longissimus dorsi* muscle by sectioning the half-carcass between the 12nd and 13rd ribs. Fat thickness was also measured in this region with a caliper.

The experimental design was completely randomized, with five treatments and six replications. Analyses of variance were run using the model: $Yij = \mu + Ti + eij$, where: Yij = observation regarding the animal j receiving treatment i; μ = overall mean of each variable; Ti = effect of treatment i, i = 1..., 5; eij = random error associated with observation Yij. After analysis of variance, means were tested by Tukey's test at 5% probability, using the software Statistical Analysis System (SAS, 2001).

Results and discussion

Treatments had a significant effect ($p > 0.05$) on the intake of dry matter, expressed as g day^{-1} and as %BW (Table 3).

Table 3. Intake of dry matter, nutrients and water in sheep fed diets containing fresh or dehydrated spineless cactus replacing Tifton 85 hay.

Nutrient intake	Diets					SEM[#]	P-value
	HA	HADC	HAFC	DC	FC		
Dry matter							
g day^{-1}	658 ab	885 a	748 ab	890 a	607 b	0.064	0.0121
% BW	2.96 b	3.81 a	3.27 b	3.82 a	2.83 b	0.208	0.0154
Crude protein							
g day^{-1}	138 ab	165 a	139 ab	134 ab	114 b	0.011	0.0190
% BW	0.62	0.71	0.62	0.57	0.53	0.042	0.0712
Neutral detergent fiber							
g day^{-1}	409 a	383 a	330 a	225 b	165 b	0.036	0.0003
% BW	1.83 a	1.65 a	1.43 b	0.97 c	0.77 c	0.127	<0.0001
Total Digestible Nutrients							
g day^{-1}	446 b	619 a	567 ab	673 a	443 b	19.52	0.0121
% BW	2.23 c	2.97 ab	3.18 a	3.27 a	2.65 bc	10.03	0.0154
Water							
Voluntary intake (kg day^{-1})	2.22 c	3.47 b	0.57 d	4.13 a	0.52 d	0.44	<0.0001
Diet (kg day^{-1})	0.11 c	0.16 c	4.03 b	0.17 c	5.57 a	0.76	<0.0001
Total (kg day^{-1})	2.33 c	3.63 b	4.60 b	4.30 b	6.09 a	0.52	0.0016

Different letters in the same row indicate significant differences ($p < 0.05$) by Tukey's test. [#]Standard error of the mean.
Source: elaborated by author.

Diets of dehydrated spineless cactus and dehydrated spineless cactus + Tifton 85 hay promoted greater intake ($p < 0.05$) of dry matter (DMI). It can be inferred that the higher content of dry matter (88.20% DM for HADC and 88.25% DM for DC) and the highest passage rates, caused by high ruminal degradability of spineless cactus (Batista et al., 2009) were possibly responsible for considerable increases in CMS.

The diet consisting of fresh spineless cactus mixed with the concentrate (FC) propitiated the lowest dry matter intake. Probably, the high production of gas during fermentation promoted ruminal distension and therefore drop in DMI (Santos, Batista et al., 2010). However, mucopolysaccharides present in fresh spineless cactus may have increased the viscosity of rumen liquid and impeded the coalescence of gas bubbles produced during fermentation (Sãenz, Sepúlveda, & Matsuhiro, 2004) causing ruminal distension.

The diet HADC had higher ($p < 0.05$) CPI (g day^{-1}) than the FC diet. Although isonitrogenous, the HADC diet showed higher CPI than the FC diet, probably due to the increased DMI of the diet containing hay. The association of hay with cacti seems to favor the DMI and CPI by small ruminants (Tegegne, Kijora, & Peters, 2007; Vieira et al., 2008).

Regarding TDNI (g day^{-1}), the diet DC led to the intake of 672 g day^{-1}, which did not differ ($p > 0.05$) from 619 g day^{-1} observed in animals fed HADC diet. Lower TDNI (day^{-1}) ($p > 0.05$) were observed in diets HA and FC.

The diet based on dehydrated spineless cactus (DC) promoted the highest ($p < 0.05$) voluntary intake of water by the animals (Table 3), while the lower intake was found in animals fed diets comprised of hay + fresh spineless cactus (HAFC) or fresh spineless cactus (FC). The voluntary intake of water in the DC diet was possibly associated with increased dry matter intake observed with this diet and also due to the high content of mineral matter of dehydrated spineless cactus (19.2% MM). The consumption of fresh spineless cactus results in reduced voluntary water intake (Bispo et al., 2007), given the high amount of water in the fresh spineless cactus.

The percentaged of fecal dry matter were 38.5; 27.6; 27.2; 20.4 and 33.0% for treatments hay (HA), hay + dehydrated spineless cactus (HADC), hay + fresh spineless cactus (HAFC), dehydrated spineless cactus (DC) and spineless cactus (FC), respectively, with higher values ($p < 0.05$) in HA and lower in DC. This observation indicates that it is not the presence of water in the spineless cactus which causes watery feces because the DC diet showed less content of fecal dry matter that the FC diet, even with higher levels of dietary dry matter of that diet in relation to this one (Table 2). Therefore, it is possible that organic acids and minerals, especially oxalate, present in spineless cactus increase the osmolality of the intestinal digesta increasing water excretion via feces (Waal, Zeeman, & Combrinck, 2006; Batista et al., 2009).

The final body weight and the total weight gain and average daily gain were similar ($p > 0.05$) between all treatments (Table 4). The average daily weight gain ranged from 94 to 142 g day^{-1} and was positively correlated with TDN intake ($r = 0.80252$, $p < 0.0001$).

Table 4. Performance of sheep fed diets containing fresh or dehydrated spineless replacing Tifton hay.

Performance	Diets					SEM[#]	P-value
	HA	HADC	HAFC	DC	FC		
Initial body weight (kg)	19.1	18.9	19.0	19.1	18.8	0.35	0.994
Final body weight (kg)	25.0	27.4	26.2	27.2	23.2	0.67	0.546
Weight gain							
Total (kg)	5.9	8.5	7.2	8.2	5.6	0.45	0.165
Average daily (g day^{-1})	98.5	141.8	119.8	136.3	93.8	7.56	0.163
Hot carcass weight (kg)	10.7b	13.6a	12.9a	14.4a	13.2a	0.36	0.007
Cold carcass height (kg)	10.4b	13.2a	12.4 ab	13.9a	12.8ab	0.35	0.009
Cooling losses (%)	3.9	3.0	3.8	3.8	3.8	0.25	0.733
TGI content (kg)	1.5a	1.5a	1.5a	1.2ab	1.0b	0.07	0.050
Carcass yield (%)	44.9b	49.3a	49.9a	51.7a	51.8a	0.63	< 0.0001
Loin eye area (cm^2)	10.4b	13.5a	11.2ab	13.9a	11.3 ab	0.40	0.010
Fat thickness (mm)	1.0	1.3	1.2	1.5	1.3	0.16	0.947
Internal fat (g)	273	355	275	406	363	27.8	0.485
Feed conversion	8.4	7.5	8.2	7.3	7.6	0.55	0.521

Different letters in the same row indicate significant differences ($p < 0.05$) by Tukey's test. [#]Standard error of the mean.

Source: elaborated by author.

Cold carcass weights were higher ($p < 0.05$) for animals fed HADC and DC when compared to HA. Differences in energy intake (TDN), higher for animals fed dehydrated spineless cactus, have been reflected in the deposition of tissue in the carcass of sheep and favored the gain in carcass of these animals (Piola Junior et al., 2009; Pereira et al., 2010). This inference is supported by the values of loin eye area, which were higher in animals fed DC and HADC than those fed HA.

Carcass yield was lower (44.9%) for animals fed HA. Probably, the lowest carcass weight and the content of the gastrointestinal tract (CTGI) resulted in lower carcass yield in this treatment (Table 4). Animals fed DC or FC had lower CTGI and higher carcass yield. Differences observed for CTGI depend on the NDF intake, since diets containing higher percentage of NDF increase food residence time in the gastrointestinal tract (Muniz et al., 2012), even after fasting imposed to animals before slaughter.

Cooling losses were 3.66%, with no differences between treatments ($p > 0.05$). It is likely that this loss is associated with reduced fat thickness, 1.26mm ± 0.16 mm, in the carcass of animals. Admittedly, hair sheep exhibit low subcutaneous fat deposition, however, these animals accumulate large amounts of internal fat (Medeiros et al., 2011). Although there was no effect ($p > 0.05$) of treatments on the deposition of internal fat, we observed mean values of 334.4 g ± 27.8 g, or 2.7%, of cold carcass weight of animals slaughtered.

Weight values of meat cuts were influenced ($p < 0.05$) by the diets, they were heavier for sheep fed dehydrated spineless cactus (DC) or hay + dehydrated spineless cactus (HADC). Meat cuts (kg) showed high positive correlation with the weight of cold carcass, so that variations in the cold carcass weight are reflected in the weight of the cuts (Table 5).

Table 5. Meat cuts and non-carcass components of sheep fed diets containing fresh or dehydrated spineless replacing Tifton hay.

	Diets						
	HA	HADC	HAFC	DC	FC	SEM[#]	P-value
Carcass cuts (kg)							
Leg	1.59 b	2.05 a	1.96 ab	2.10 a	1.86 ab	0.049	0.0030
Shoulder	0.99 b	1.23 a	1.20 ab	1.26 a	1.14 ab	0.028	0.0084
Loin	0.48 b	0.65 a	0.60 ab	0.66 a	0.55 ab	0.021	0.0501
Rib	0.89 b	1.15 a	1.05 ab	1.21 a	0.99 ab	0.036	0.0503
Carcass cuts (% BW)							
Leg	31.0	31.0	31.6	30.3	31.0	0.243	0.5268
Shoulder	19.3	18.7	19.3	18.2	18.9	0.166	0.1440
Loin	9.1	9.8	9.6	9.3	9.0	0.173	0.6699
Rib	17.1	17.5	16.9	17.4	16.9	0.219	0.8937
	Non-carcass components (kg)						
Skin	1.55 b	2.33 a	2.12 ab	2.63 a	2.23 ab	0.097	0.0016
Blood	1.11	1.29	1.23	1.43	1.17	0.051	0.4003
Liver	0.36 b	0.48 ab	0.41 b	0.58 a	0.40 b	0.020	0.0015
Kidney	0.07 b	0.10 a	0.09 ab	0.10 a	0.08 ab	3.078	0.0210
Heart	0.12	0.14	0.14	0.14	0.12	4.505	0.4059
Rumem	0.49	0.56	0.51	0.55	0.49	0.017	0.6310
Reticulum	0.08	0.12	0.10	0.11	0.09	0.004	0.1126
Omasum	0.05	0.07	0.06	0.06	0.06	0.002	0.4388
Abomasum	0.11	0.13	0.14	0.14	0.12	0.005	0.4950
Small intestine	0.53 b	0.62 ab	0.57 ab	0.70 a	0.53 b	0.021	0.0501
Large intestine	0.25 b	0.29 ab	0.26 b	0.36 a	0.29 ab	0.012	0.0378
Non-carcass components (% BW)							
Skin	6.21 c	8.46 ab	8.07 bc	9.67 ab	10.06 a	0.336	0.0003
Blood	4.46	4.64	4.65	5.28	4.92	0.127	0.2762
Liver	1.43 c	1.57 bc	1.72 b	2.13 a	1.78 b	0.053	<0.0001
Kidney	0.30	0.35	0.36	0.36	0.34	0.008	0.0718
Heart	0.47	0.51	0.53	0.51	0.53	0.015	0.6449
Rumem	1.97	1.93	2.03	2.01	2.05	0.034	0.8260
Reticulum	0.34	0.43	0.38	0.41	0.39	0.012	0.1686
Omasum	0.22	0.22	0.25	0.22	0.24	0.008	0.4541
Abomasum	0.47	0.48	0.51	0.52	0.49	0.014	0.7751
Small intestine	2.14	2.24	2.16	2.58	2.21	0.066	0.1853
Large intestine	1.01 b	1.04 b	1.00 b	1.31 a	1.23 ab	0.036	0.0060

Different letters in the same row indicate significant differences ($P<0.05$) by Tukey's test. [#]Standard error of the mean.

Source: elaborated by author.

When corrected to body weight, meat cuts (% BW) showed no differences between treatments. Given the similarity between weight and physiological stages of slaughtered animals, it was not possible to identify differences in the regional composition of sheep carcass (Azeredo et al., 2005).

Non-carcass components (kg; % BW) were influenced ($p < 0.05$) by different diets, with higher values found for diets containing dehydrated spineless cactus (DC) and hay + dehydrated spineless cactus (HADC). The weight of liver, skin and intestine were greater for animals fed DC and HADC, probably due to the higher TDNI (g day^{-1}) of these diets.

Non-carcass components (% BW) showed greater proportions ($p < 0.05$) of liver and large intestine in sheep fed DC. Probably, the greater dry matter intake of the DC diet (Table 3) accounted for the greater proportions of liver observed. Considering the large intestine, the highest passage rate of DC associated with increased osmolality of the intestinal digesta promoted adaptive distention of the cecum-colon and increased fermentation rate in these compartments, culminating in a higher proportion of the large intestine relative to body weight (Lewis & Dehority, 1985; Fontenele et al., 2010).

Conclusion

Partial or total replacement of Tifton 85 hay with fresh or dehydrated spineless cactus, in complete diets for sheep, increases the weight of the cold carcass and non-carcass components.

The water content of spineless cactus is not responsible for the watery stools observed in animals fed high levels of this plant.

References

Azeredo, D. M., Osório, M. T. M., Osório, J. C. S., Mendonça, G., Barbosa, J. & Esteves, R. M. (2005). Crescimento e desenvolvimento de ovinos Corriedale não castrados, castrados e criptorquidas abatidos com diferentes pesos. *Revista Brasileira de Agrociência*, *11*(3), 339-345.

Batista, Â. M. V., Mustafa, A. F., McAllister, T., Wang, Y., Soita, H., & McKinnon, J. J. (2003). Effects of variety on chemical composition, *in situ* nutrient disappearance and *in vitro* gas production of spineless cacti. *Journal of the Science of Food and Agriculture*, *83*(5), 440-445.

Batista, Â. M. V., Ribeiro Neto, A. C., Lucena, R. B., Santos, D. C., Dubeux Junior, J. B., & Mustafa, A. F. (2009). Chemical composition and ruminal degradability of spineless cactus grown in Northeastern Brazil. *Rangeland Ecology & Management*, *62*(3), 297-301.

Bispo, S. V., Ferreira, M. A., Véras, A. S. C., Batista, Â. M. V., Pessoa, R. A. S., & Bleuel, M. P. (2007). Palma forrageira em substituição ao feno de capim-elefante. Efeito sobre consumo, digestibilidade e características de fermentação ruminal em ovinos. *Revista Brasileira de Zootecnia*, *36*(6), 1902-1909.

Cezar, M. F., & Sousa, W. H. (2007). *Carcaças ovinas e caprinas: obtenção, avaliação e classificação*. Uberaba, MG: Agropecuária Tropical.

Ferreira, M. A., Silva, F. M., Bispo, S. V., & Azevedo, M. (2009). Estratégias na suplementação de vacas leiteiras no semiárido do Brasil. *Revista Brasileira de Zootecnia*, *38*(Supl.), 322-329.

Fontenele, R. M., Pereira, E. S., Pimentel, P. G., Mizubuti, I. Y., Monte, A. L. S., Candido, M. J. D., ... & Rocha Junior, J. N. (2010). Níveis de energia metabolizável em rações de ovinos Santa Inês: peso dos órgãos internos e do trato digestório. *Semina*, *31*(4), 1095-1104.

Lewis, S. M., & Dehority, B. A. (1985). Microbiology and ration digestibility in the hindgut of the ovine. *Applied and Environmental Microbiology*, *50*(2), 356-363.

Medeiros, G. R., Costa, R. G., Andrade, M. G. L. P., Azevedo, P. S., Medeiros, A. N., Pinto, T. F., ... Suassuna, J. M. (2011). Estado de engorduramento da carcaça de ovinos Santa Inês e Morada Nova abatidos com diferentes pesos. *Actas Iberoamericanas de Conservación Animal*, *1*(1), 243-246.

Muniz, E. B., Mizubuti, I. Y., Pereira, E. S., Pimentel, P. G., Ribeiro, E. L. A., & Pinto, A. P. (2012). Cinética ruminal da fração fibrosa de volumosos para ruminantes. *Revista Ciência Agronômica*, *43*(3), 604-610.

Pereira Filho, J. M., Silva, A. M., A. & Cézar, M. F. (2013). Manejo da Caatinga para produção de caprinos e ovinos. *Revista Brasileira de Saúde e Produção Animal*, *14*(1), 77-90.

Pereira, E. S., Pimentel, P. G., Fontenele, R. M., Medeiros, A. N., Regadas Filho, J. G. L., & Villarroel, A. B. S. (2010). Características e rendimentos de carcaça e de cortes em ovinos Santa Inês, alimentados com diferentes concentrações de energia metabolizável. *Acta Scientiarum. Animal Sciences*, *32*(4), 431-437.

Piola Junior, W., Ribeiro, E. L. A., Mizubuti, I. Y., Silva, L. D. F., Sousa, C. L., & Paiva, F. H. P. (2009). Níveis de energia na alimentação de cordeiros em confinamento e composição regional e tecidual das carcaças. *Revista Brasileira de Zootecnia*, *38*(9), 1797-1802.

Sãenz, C., Sepúlveda, E., & Matsuhiro, B. (2004). *Opuntia* spp mucilage's: a functional component with industrial perspectives. *Journal of Arid Environments*, *57*(3), 275-290.

Santos, J. R. S., Cezar, M. F., Sousa, W. H., Cunha, M. G. G., Pereira Filho, J. M., & Sousa, D. O. (2011) Carcass characteristics and body components of Santa Inês lambs in feedlot fed on different levels of forage cactus meal. *Revista Brasileira de Zootecnia*, *40*(10), 2273-2279.

Santos, M. V. F., Farias, I., Lira, M. A., Nascimento, M. M. A., Santos, D. C., & Tavares Filho, J. J. (1998). Colheita da palma forrageira (*Opuntia ficus indica* Mill) cv. gigante sobre o desempenho de vacas em lactação. *Revista Brasileira de Zootecnia*, *27*(1), 33-39.

Santos, A. O. A., Batista, Â. M. V., Mustafa, A., Amorim, G. L., Guim, A., Moraes, C., ... Andrade, R. (2010). Effects of Bermudagrass hay and soybean hulls inclusion on performance of sheep fed cactus-based diets. *Tropical Animal Health and Production*, *42*(3):487-494.

Santos, M. V. F., Lira, M. A., Dubeux Junior, J. C. B., Guim, A., Mello, A. C. L., & Cunha, M. V. (2010).

Potential of Caatinga forage plants in ruminant feeding. *Revista Brasileira de Zootecnia*, *39*(supl.), 204-215.

Statistical Analysis System [SAS]. (2001). *User's Guide: stat. Release 8.1.* Cary, NC: SAS Instituite.

Silva, D. J., & Queiroz, A. C. (2002). *Análise de alimentos: métodos químicos e biológicos* (3a ed.). Viçosa, MG: UFV, Imprensa Universitária.

Tegegne, F., Kijora, C., & Peters, K.J. (2007). Study on the optimal level of cactus pear (*Opuntia ficus-indica*) supplementation to sheep and its contribution as source of water. *Small Ruminant Research*, *72*(2), 157-164.

Véras, R. M. L., Ferreira, M. A., Cavalcanti, C. V. A., Véras, A. S. C., Carvalho, F. F. R., Santos, G. R. A., ... Maior Júnior, R. J. S. (2005). Substituição do milho por farelo de palma forrageira em dietas de ovinos em crescimento. Desempenho. *Revista Brasileira de Zootecnia*, *34*(1), 249-256.

Véras, R. M. L., Ferreira, M. A., Véras, A. S. C., Carvalho, F. F. R., Cavalcanti, C. V. A., Santos, G. R. A., ... Sampaio, C. B. (2005). Substituição do milho por farelo de palma forrageira em dietas para ovinos em crescimento. consumo e digestibilidade. *Revista Brasileira de Zootecnia*, *34*(1), 351-356.

Vieira, E. L., Batista, Â. M. V., Guim, A., Carvalho, F. F., Nascimento, A. C., Araújo, R. F. S., & Mustafa, A. F. (2008). Effects of hay inclusion on intake, *in vivo* nutrient utilization and ruminal fermentation of goats fed spineless cactus (*Opuntia ficus-indica* Mill) based diets. *Animal Feed Science and Technology*, *141*(3), 199-208.

Waal, H. O., Zeeman, D. C., & Combrinck, W. J. (2006). Wet faeces produced by sheep fed dried spineless cactus pear cladodes in balanced diets. *South African Journal of Animal Science*, *36*(5), 10-13.

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