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Substitution of *Pennisetum purpureum* by *Opuntia ficus-indica* and *Mimosa tenuiflora* in the diet of lambs[1]

Substituição do "Pennisetum purpureum" por "Opuntia ficus-indica" e "Mimosa tenuiflora" na dieta de ovinos[1]

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SUMMARY

The objectives of this study were to quantify the apparent digestibility of the diet components and the performance of lambs consuming increasing levels of the balanced (weight) mixture of *Opuntia ficus indica* bran and *Mimosa tenuiflora* leaves and fine branches hay substituting 0, 33 and 67% of *Pennisetum purpureum* hay, in a 60% roughage fodder to 40% concentrate diet formulated to a daily live body weight gain of 150 g/animal. Experiment was carried out at UFCG facilities, in Patos-PB, using 18 non-emasculated lambs with (20.4±1.16) kg (mean weight±SE). Dry matter, OM, CP, EE and total carbohydrates CD were affected by the levels of the mixture (P<0.05) according to a second degree model, with minimum CD values between 34 and 52% of *P. purpureum* hay replacement. Neutral detergent fiber and ADF CD decreased linearly (P<0.05), and those for CE and NFC were not affected (P>0.05). The inclusion of the mixture affected linear and positively the daily mean body weight gain (120, 149 and 170 g/animal, respectively for 0, 33 and 67% *P. purpureum* hay replacement levels), and DM, OM, CP, TCH and NFC consumptions. The balanced mixture of *Opuntia ficus indica* bran and *Mimosa tenuiflora* hay can replace up to 67% of the roughage fodder fraction (*P. purpureum*) of Santa Inês lamb diet and improve the daily body weight gain by 50 g/animal.

Keywords: cactus, small ruminants, tree fodder

RESUMO

Os objetivos deste estudo foram quantificar a digestibilidade aparente dos componentes da dieta e o desempenho de cordeiros alimentados com níveis crescentes de uma mistura balanceada (peso) de farelo de *Opuntia ficus indicae* e feno de *Mimosa tenuiflora* em substituição a 0, 33 e 67% do feno *Pennisetum purpureum*, em uma dieta com 60% de volumoso e 40% de concentrado, formulada para um ganho de peso diário de 150 g/animal. O experimento foi conduzido na UFCG, Patos-PB, usando 18 cordeiros inteiros com (20,4±1,16) kg (peso médio±EP). O CD da MS, MO, PB, EE e dos carboidratos totais foram afetados pelos níveis da mistura (P<0,05) de acordo com um modelo quadrático, com mínimo valor de CD entre 34 e 52% de substituição do feno de *P. purpureum*. A digestibilidade da FDN e da FDA decresceu linearmente (P<0,05), e as da EB e dos carboidratos não fibrosos não foram afetadas (P>0,05). A inclusão da mistura afetou linear e positivamente o ganho de peso médio diário (120, 149 e 170g/animal, respectivamente para 0, 33 e 67% de substituição do feno de *P. purpureum*), e o consumo de MS, MO, PB, carboidratos totais e não fibrosos. A mistura balanceada do farelo de *Opuntia fícus indica* e do feno de *Mimosa tenuiflora* pode substituir até 67% da fração volumosa (*P. purpureum*) da dieta de cordeiros Santa Inês e melhorar o ganho de peso médio diário em 50g/animal.

Palavras-chave: cactácea, forragem arbórea, pequenos ruminantes

INTRODUCTION

Approximately 1.6% (16.2 million) of the world sheep population grows in Brazil, mostly in its tropical semiarid northeast region (IBGE, 2007) in which the Caatinga vegetation predominates. These natural seasonal herbaceous and perennial shrub and tree communities provide most of the forage consumed by sheep in the rainy season, however during the dry season food is scarce (ZIGUER et al., 2011), and animals need to be supplemented. *Pennisetum purpureum* Schumach is a water and soil demanding grass used to feed ruminants in Brazil, but its growth and quality decrease in the 7-to-8-month long dry season of the tropical semiarid region of northeast Brazil (CAMURÇA et al., 2002), and ranching should be based on xerophytes such as the cactus *Opuntia fícus-indica* Mill and the legume tree *Mimosa tenuiflora* (Willd.) Poiret (CASTRO et al., 2007).

The mentioned cactus is adapted to the dry tropical region of northeast and is capable to produce a palatable forage rich in non fibrous carbohydrates Brazil (VERAS et al., 2002; MELO et al., 2003). Cattle, goat and sheep consume it as a substitute of the concentrate (up to 75%) or roughage (up to 56%) fraction of the diet (VERAS et al., 2002; BISPO et al., 2007).

The mentioned legume tree occurs naturally in the Caatinga and its fine branches and fruits are protein rich and palatable to ruminants (MAIA, 2004; MOREIRA et al., 2006). Although i*n vitro* digestibility of *M. tenuiflora* fine branches is low (< 22%), depending on the vegetative stage (MOREIRA et al., 2006) and the presence of compounds such as condensed tannins (BEELEN et al., 2006). Cordão et al. (2008) reported body weight gain of 1.14kg in a 56 day experiment with Santa Ines sheep fed 33% *M. tenuiflora* and 66% *P. purpureum* hay.

This study determined the apparent digestibility of the components of the diets and the performance of Santa Inês lambs fed increasing levels (0, 33 and 67%) of the balanced (weight) *O. fícus indica* and *M. tenuiflora* fine branches hay mixture [(Op+Mim)mix] as a substitute of *P. purpureum* hay.

MATERIAL AND METHODS

This study was carried out at the Federal University of Campina Grande, Patos-PB, Brazil, from November/2009 to January/2010. Mean daily maximum and minimum temperatures were 38.8 and 24.5ºC, respectively. Air moisture averaged 76.2% at 09:00 h and 39.9% at 15:00 h. Composition of *P. purpureum* and *M. tenuiflora* hay, ground corn, and *O. fícus-indica*, wheat and soya bran (Table 1) were determined and roughage fodder and concentrate comprised 60% and 40% of the diets, respectively (Table 2).

Pennisetum purpureum hay came from approximately 100-day-growth plants that were cut, chopped and sun-dried (10-to-12% moisture). Cladodes were harvested in September 2008, cut in 3 cm wide pieces and sun-dried. Leaves and 10-to-15mm thick branches were cut from *M. tenuiflora* trees at full growth stage in May and June 2009, and processed similarly to *P. purpureum*. Dried materials were reprocessed separately in a chopper machine with a 5 mm-mesh sieve.

Experimental diets [0, 33 and 67% substitution of *P. purpureum* hay by the balanced (weight) (Op+Mim)mix], adjusted to 150g of daily body weight gain / lamb (NRC, 2007) were assigned to eighteen non-emasculated, 20.4kg ±

1.2kg (mean weight± SE), three-month-old Santa Inês lambs, according to a complete block (lamb weight) design with six replications and 18 plots (18 lambs).

The 77-day performance trial had an initial 14-day adaptation period and a 63-day period of data collection during which each lamb was confined in 1.30m x 0.75m wood stalls with individual water and food supplies. Experimental diets were supplied twice a day (7h e 14h), with a daily 20% surplus of the quantity consumed in the previous day.

Daily body weight gain was determined by the difference between the final and initial body weights divided by the number of days of the experimental period (63 days). Individual daily water and solid food consumptions were determined by the difference between the offered and unconsumed quantities. Water consumption was corrected by the average evaporation measured in two recipients similar to the ones present in each stall.

Offered and unconsumed solid food was sampled daily for each animal. These samples were mixed and analyzed for DM, OM, NDF, ADF, CP and EE (DETMANN et al., 2012). For *O. fícus indica* and soya bran, NDF was determined according to Van Soest et al. (1991) recommendations. Contents of NDF and ADF were corrected for ashes and proteins (SNIFFEN et al., 1992). Total carbohydrate was estimated by %TC = 100 – (%CP + %EE + %Ashes), NFC by %NFC = %TC - %NDFcp (HALL, 1999), ME by ME = ingested CE - (fecal CE + CE in urine + CE in excreted gases), and CE in excreted gases = GPc x ingested CE / 100, and GPc = Gas production = 4.28 + 0.059*CDCE (CDCE= coefficient of digestibility of crude energy) - (BLAXTER, 1962).

Table 1. Bromatological composition of the ingredients used in the experimental diets

Composition (% DM)	*P. purpureum* hay	*O. fícus indica* bran	*M. tenuiflora* hay	Soya bran	Ground corn	Wheat bran
DM	94.03	91.60	92.72	92.87	91.81	93.10
Ashes	10.11	11.55	3.78	7.58	10.19	5.85
OM	89.89	88.45	96.22	92.42	89.81	94.15
CP	4.28	10.20	8.27	47.26	8.86	14.77
NDFap	78.56	30.70	58.16	18.04	14.45	39.37
ADFap	47.56	15.22	51.26	11.05	6.54	24.46
CE(Mcal/kg)	4.459	4.366	4.926	4.936	4.824	4.912
EE	5.94	3.09	6.53	4.37	5.45	6.83
TC	79.66	75.16	81.42	40.79	75.49	72.55
NFC	1.10	44.46	23.26	22.75	61.04	33.18
TP		-	15.0	-	-	-
TT		-	10.4	-	-	-
CT		-	6.26	-	-	-
Ca	0.78	4.10	1.05	0.93	0.78	0.49
P	0.019	0.017	0.056	0.057	0.027	0.077

DM = dry matter, OM = organic matter, CP = crude protein, NDFap = neutral detergent fiber corrected for ashes and protein, ADFap = acid detergent fiber corrected for ashes and protein, CE = crude energy, EE = ether extract, TC = total carbohydrates, NFC = non fibrous carbohydrates, TP = total phenols, TT = total tannins, CT = condensed tannins, Ca = calcium, P = phosphorus.

Table 2. Proportion of the ingredients and chemical composition (%DM) of the experimental diets, according to the levels of *P. purpureum* substitution by the balanced (weight) mixture of *O. fícus indica* bran and *M. tenuiflora* hay

Ingredients	Substitution levels of *P. purpureum*		
	0%	33%	67%
P. purpureum hay	60.00	40.00	20.00
M. tenuiflora hay	0.00	10.00	20.00
O. fícus indica bran	0.00	10.00	20.00
Soya bran	20.00	20.00	20.00
Ground corn	10.00	8.00	8.50
Wheat bran	9.00	11.30	11.00
Mineral mixture	1.00	0.70	0.50
Total	100.00	100.00	100.00
Chemical composition (%)			
Dry matter	93.53	93.17	92.78
Organic Matter	90.02	90.83	91.46
Neutral detergent fiber*	55.73	49.52	42.65
Acid detergent fiber*	33.27	30.44	27.16
Crude protein	14.24	15.39	16.38
Crude energy (Mcal/kg)	4.59	4.64	4.69
Ether extract	5.60	5.42	5.20
Total carbohydrates	70.18	70.02	69.88
Non fibrous carbohydrates	14.45	20.50	27.23
Total phenols	1.01	2.30	3.81
Total tannins	0.66	1.68	2.62
Condensed tannins	0.028	0.424	1.060

*Corrected for ashes and protein.

Digestibility trial lasted 21 days (16-day adaptation period, and five days for total urine and feces collection and sampling of offered and unconsumed food). During this period, each lamb was confined in 1.00m x 0.60m metabolic cages with individual water and food supplies. Experimental diets were supplied twice a day (07:00 h e 14:00 h), with a daily 20% surplus of the quantity consumed in the previous day.

Statistical analysis were performed on the coefficients of apparent digestibility and daily consumptions data sets of dry matter (CDDM and CDM, respectively), organic matter (CDOM and COM), neutral (CDNDF and CNDF) and acid detergent fiber (CDADF and CADF), crude protein (CDCP and CCP), crude energy (CDCE and CCE), ether extract (CDEE and CEE), and total (CDTC and CTC) and non fibrous carbohydrates (CDNFC and CNFC). Daily body weight gain (BWG), consumption of metabolizable energy (CME) and water (CW), and food conversion (FC = mean daily consumption of DM ⁄ mean daily body weight gain)) were also considered.

Total feces excreted by each lamb were weighed daily to estimate the coefficients of apparent digestibility. Similarly, total urine was collected in a plastic pail with 10mL of a 50% chloride acid solution, to estimate metabolizable energy.

The coefficients of digestibility (CD) of each bromatological component of the diet were estimated by:

$$\text{CD \%} = \frac{(\text{Consumed Quantity} - \text{Excreted Quantity in feces}) \times 100}{\text{Consumed Quantity}}$$

Prior to analysis of variance, homogeneity of variance between treatments was checked by F_{max} test, and Regression Analysis was applied to correlate the levels of *P. purpureum* substitution by (Op+Mim)mix and the studied variables using, respectively, the GLM and the GSR routine of Statistica 7.0 (P = 0.05) - (STATSOFT, 2005).

RESULTS AND DISCUSSION

Inclusion of (Op+Mim)mix increased linearly BWG, CDM, COM and CCP (Table 3), especially when expressed in units of metabolic body weight (g/kg$^{0.75}$) (r^2>0.62). Consumption of Metabolic Energy and Food Conversion were not affected. Regression equation indicated that BWG increases approximately 0.75g/animal.day to each percentage point of substitution of *P. purpureum* hay, or equivalently, the substitution of 67% of *P. purpureum* by the (Op+Mim)mix adds up an average of 50g to the daily body weight gain of Santa Inês lambs.

The observed mean values for BWG are comparable to the values reported by Parente et al. (2009) (BWG = 171.6g/ animal.day) for ½ Santa Inês x ½ undefined breed fed a 31% concentrate: 69% Tifton grass diet, and surpassed the ones by Camurça et al. (2002) (BWG = 87 to 117g/animal.day) for Santa Ines lambs fed 30% concentrate and 70% *Cenchrus ciliaris* or *Urochloa mosambicensis* or *Panicum molle* grass hay. However, the tree *Manihot glaziovii* Muell. Arg. produces protein rich, palatable leaves that can be used in a 60% roughage fodder: 40% concentrate diet and result in average BWG of 253.35g/ Santa Inês lamb (CASTRO et al. 2007).

Table 3. Means, regression equations for the variables (Y) daily body weight gain (BWG), consumptions of dry matter (CDM), organic matter (COM), crude protein (CCP) and metabolic energy (CME), and food conversion (FC), according to the level (X) of substitution of *Pennisetum purpureum* hay by the balanced mixture of *Opuntia ficus indica* bran and *Mimosa tenuiflora* fine branches hay [(Op+Mim)mix] in the diet of Santa Ines male lambs, and respective levels of significance (P) and coefficients of determination (r^2)

Variables	Levels (X) of substitution of P. purpureum by (Op+Mim)mix			Regression Equation	P	r^2
	X=0%	X=33%	X=67%			
BWG (g/an.day*)	120.0	149.0	170.0	Y=120.53+0.75X	0.007	0.396
CDM (g/an.day)	982.0	1141.8	1252.6	Y=990.99+4.04X	0.027	0.271
CDM (g/kg$^{0.75}$)	90.8	102.5	110.00	Y=91.59+0.29X	0.000	0.628
COM (g/an.day)	880.0	1034.8	1146.1	Y=888.03+3.97X	0.018	0.304
COM (g/kg$^{0.75}$)	81.3	92.8	100.33	Y=82.06+0.28X	0.000	0.677
CCP (g/an.day)	150.2	183.8	209.33	Y=151.70+0.88X	0.004	0.416
CCP (g/kg$^{0.75}$)	13.8	16.7	18.2	Y=14.07+0.07X	0.000	0.728
CME (Mcal/day)	2.7	2.6	2.5	Y=2.61	0.702	0.010
CME (Mcal/kg$^{0.75}$)	0.24	0.23	0.22	Y=0.23	0.319	0.066
FC	8.20	7.78	7.35	Y=7.77	0.325	0.064

*g/an.day = g/animal.day.

The linear positive effect of the (Op+Mim)mix on CDM was certainly due to the palatability and NFC of *Opuntia* bran (Table 1), and had a positive effect on BWG. Observed total daily CDM increased from 982.03 g/animal.day, for X=0%, to 1252.60 g/animal.day, for X=67% (Table 3). These values are higher than the reported by Camurça et al. (2002): CDM = 871.43, 787.30, 943.14 or 1044.11g/animal.day for Santa Inês lambs fed 70% *P. purpureum*, *Cenchrus ciliaris* L., cv. Aridus, *Urochloa mosambicensis* Hack-Daudy or *Panicum molle* Swartz, respectively, and 30% concentrate, and are similar to the reported by Castro et al. (2007): 1160g⁄animal.day≤CDM≤1220g⁄animal. day for Santa Inês lambs fed *M. glaziovii* hay (20 to 80% of the 60%-roughage fodder fraction of the diet).

Consumption of crude protein increased linearly (P<0.05) whith *P. purpureum* hay substitution (Table 3). Values for CCP (from 150.16 to 209.33g/animal.day or from 13.83 to 18.16g/kg$^{0.75}$) were always above 30kg-sheep requirements reported by NRC (2007) (137g/animal.day, or 10.69g/kg$^{0.75}$) indicating that the studied diets were composed by high quality components. Camurça et al. (2002) and Araújo et al. (2009) observed lower CCP (~135g/animal.day) and BWG (74g/animal.day by Santa Inês and crossbred lambs fed 70% *P. purpureum* and 30% concentrate, when studying the substitution of the concentrate fraction by *O. ficus indica* bran). Consumption of CP reported by Castro et al. (2007) (205.88 g/animal.day or 19.02g/kg$^{0.75}$) for Santa Inês lambs fed 60% *Manihot sp*. hay were similar to the maximum CCP reported in the present study (209.33 g/animal.day or 18.16g/kg$^{0.75}$), but resulted in higher BWG (253.35g/animal.day) than the reported in the present study (119.77 to 170.42g/animal.day).

Food conversion was not affected (P>0.05) by the (Op+Mim)mix inclusion in the diet. Mean FC were 8.20, 7.78 and 7.35 for 0, 33 and 67%, respectively, of *P. purpureum* substitution. Should all the *P. purpureum* fraction be substituted by (Op+Mim)mix, it is possible that FC may improve to values close to those in Parente et al. (2009). These authors found FC = 6.82 for lambs ½ Santa Inês x ½ SRD, fed 30% *Cynodon* spp., 32% *Leucena leucocephala* hay and 38% disintegrated whole corn plants. Although this is different from the conventional concentrate : roughage fodder concept of diet using a tree-produced ingredient and whole corn plant, their components are highly water demanding. In contrast, the suggested diet with 100% substitution of *P. purpureum* by (Op+Mim)mix would have 60% of its weight composed by xerophytes adapted to tropical dry regions and probably would result in a FC even closer to the value reported by Parente et al. (2009). Indeed, leaves from xerophytes trees, such as *M. glaziovii*, can compose up to 60% of the diet of Santa Inês lambs and result in FC = 4.92 (CASTRO et al., 2007), showing the nutritional potential of some tree species.

Substitution of *P. purpureum* did not affected CNDF, CADF, CEE, and CW, but increased linearly CTC and CNFC (Table 4). The estimated increases were, respectively, 2.96 and 3.04g/animal.day for each percentage point of *P. purpureum* substitution. Certainly, this resulted from the low fiber and highly palatable and digestible *O. ficus indica* bran in the mixture (BISPO et al., 2007). Mean CTC for 67% *P. purpureum* substitution (875.83g/animal.day) was similar to the observed by Bispo et al. (2007) - (858.50g/animal.day), when substituting 56% of *P. purpureum* by *O. ficus indica* in the diet of lambs, and by Castro et al. (2007) (813.04 g/animal.day), for lambs fed 60% (*M. glaziovii*) hay and 40% concentrate.

Substitution of *P. purpureum* hay affected linearly (P<0.05) CEE expressed in g/kg$^{0.75}$ (Table 4). It increased from 4.85g/kg$^{0.75}$ to 5.36g/kg$^{0.75}$ when *P. purpureum* hay substitution increased from 0 to 67%, respectively. Mean CEE was 57.33g/animal.day, lower than the CEE reported by Castro et al. (2007) (85.53 g/animal.day) for lambs fed 60% (*M. glaziovii*) hay and 40% concentrate. Certainly, this higher CEE results from a combination of factors, such as higher EE content of *Manihot* hay [7.34%] as opposed to 5.42 or 5.20% in the diets with (Op+Mim)mix] (Table 2), as the reported CDM values reported by these authors (1160 to 1220 g/animal.day) were considered similar to the ones of the present study (982.0 to 1252.6g/animal.day).

Table 4. Means an regression equation for the variables (Y) CNDF[a], CADF, CEE e CW according to the levels (X) of substitution of *Pennisetum purpureum* hay by the balanced (weight) mixture of *Opuntia ficus indica* bran and *Mimosa tenuiflora* fine branches hay [(Op+Mim)mix] in the diet of male Santa Inês lambs, and respective significance level (P) and coefficients of determination (r^2)

Variable (Y)	Levels of substitution of *P. purpureum* by (Op+Mim)mix			Regression equation	P	r^2
	0%	33%	67%			
CNDF (g/an.day)	523.50	548.00	523.60	Y= 531.7	0.998	0.0001
CNDF (g/kg$^{0.75}$)	48.33	49.16	45.83	Y= 47.77	0.211	0.0957
CADF (g/an.day)	302.33	332.33	333.67	Y=322.77	0.383	0.0477
CADF (g/kg$^{0.75}$)	27.83	29.66	29.33	Y=28.94	0.165	0.1168
CTC (g/an.day)	677.50	792.83	875.83	Y=683.470+2.958X	0.020	0.2908
CTC (g/kg$^{0.75}$)	62.67	71.33	76.83	Y= 63.238+0.211X	0.000	0.6561
CNFC (g/an.dya)	153.83	246.66	357.33	Y=151.331+3.038X	0.000	0.8271
CNFC (g/kg$^{0.75}$)	14.33	22.16	31.50	Y=14.123+0.256X	0.000	0.9701
CEE (g/an.day)	52.50	58.50	61.0	Y=57.33	0.169	0.1145
CEE (g/kg$^{0.75}$)	4.85	5.25	5.36	Y=4.901+0.008X	0.043	0.2317
CW (g/an.day)	2719	2943	3063	Y= 2908.33	0.486	0.0307
CW (g/kg$^{0.75}$)	248.50	261.32	265.47	Y= 258.43	0.565	0.0210

CNDF = consumption of neutral detergent fiber, CADF = consumption of acid detergent fiber, CTC = consumption of total carbohydrates, CNFC = consumption of non fibrous carbohydrates, CEE = consumption of ether extracts, CW = consumption of water.

Substitution of *P. purpureum* by (Op+Mim)mix affected quadratically CDDM, CDOM, CDCP, CDEE and CDTC (P<0.05) (estimated minimum CDs between 33%≤X≤52% of substitution), decreased linearly CDNDF and CDADF (P<0.05), and had no effect on CDCE and CDNFC (P>0.05) - (Table 5).

Both CDNDF and CDADF decreased linearly by the inclusion of (Op+Mim)mix in the diet (Table 5). Cavalcanti et al. (2006) observed the same effect on CDNDF by including *O. ficus indica* as a substitute of Tifton grass in the diet of dairy cow. These authors explained that the inclusion of this NFC-rich forage decreases fiber content and increases the rate of food passage rate, reduces rumen pH and the quantity of cellulolytic bacteria in rumen, and ultimately decreases cellulose and fiber digestion.

Mean CDCP were, respectively, 76.72, 68.58 and 68.15% for 0, 33 and 67% of *P. purpureum* substitution, with an estimated minimum value of 67.34% for X=51.71%. Probably, this reduction is due to the presence of compounds in (Op+Mim)mix, such as tannins. They may bind with proteins and hinder CP digestibility, although TT and CT contents in the diet (Table 2) were bellow the acceptable upper limit of 5% (BEELEN et al., 2006).

Table 5. Means and regression equations of the coefficient of apparent digestibility (CD) of the bromatological components of the diets as a function of the substitution level (X) of *Pennisetum purpureum* hay by the balanced mixture of *Opuntia fícus-indica* bran and *Mimosa tenuiflora* fine branches hay in the diet of Santa Inês male lambs, significance levels (P) for the linear (L) and quadratic (Q) components, and coefficients of determination (r^2 or R^2) of the regression models

CD	Substitution levels (X)			Regression equations	P		r^2 or R^2
	0%	33%	67%		L	Q	
DM	64.59	59.03	62.40	$Y=64.595-0.299X+0.004X^2$	0.005	0.009	0.418
OM	65.04	62.77	59.99	$Y=65.040-0.308X+0.004X^2$	0.004	0.006	0.442
NDF	52.02	37.40	33.37	$Y=50.185-0.278X$	0.000	NS	0.553
ADF	42.65	30.12	19.06	$Y=42.343-0.352X$	0.000	NS	0.699
CP	76.72	68.58	68.15	$Y=76.720-0.362X+0.004X^2$	0.001	0.014	0.702
CE	61.68	59.08	56.09	$Y=58.95$	0.120	0.160	0.155
EE	54.54	41.01	45.45	$Y=54.548-0.676X+0.008X^2$	0.005	0.016	0.462
TC	63.29	62.62	58.49	$Y=63.297-0.277X+0.004X^2$	0.012	0.012	0.358
NFC	83.72	90.03	90.06	$Y=87.93$	0.058	NS	0.456

DM = dry matter, OM = organic matter, NDF = neutral detergent fiber, ADF = acid detergent fiber, CP = crude protein, EE = ether extract, TC = total carbohydrates, NFC = no fibrous carbohydrates.

Substitution of *P. purpureum* had a quadratic effect on CDEE ($P<0.05$) with a minimum of 40.68% at X=41.74% of substitution. Bringel et al. (2001) reported a similar effect on CDEE when substituting *P. purpureum* by dendê kernel cake in sheep diet. Probably, due to the presence of *M. tenuiflora* hay, mean CDEE values observed in the present study showed to be lower than the reported by Silva et al. (2007) (66.26 to 72.00%) and Bispo et al. (2007) (57.47 to 65.63%) in lambs fed increasing levels of *Manihot sp.* and *O. ficus indica*, respectively.

Estimated minimum for CDTC was 58.50% for X=34.65% of *P. purpureum* substitution. This minimum slightly exceeded CDTC reported by Silva et al. (2007) (CDCT=57.63%) using 60% of *Manihot sp*. in the diet of lambs. However, any CDCT value showed in Table 5 or estimated from the respective regression equation were lower than the CDCT=73.03% reported by Bispo et al. (2007) in lambs fed 56% of *O. ficus-indica*, certainly resulting from the better quality of the roughage fodder used by these authors (87.75% of DM, 5.85% of CP, 80.67 % of NDF, 54.81 of ADF, and 84.98 TC) as compared to the *P. purpureum* plus (Op+Mim)mix.

It is concluded that Santa Inês lambs can consume a balanced (weight) mixture of *Opuntia ficus indica* bran and *Mimosa tenuiflora* fine branches hay in substitution of 67% of *Pennisetum purpureum* hay and keep satisfactory coefficients of digestibility and show a 50g-increase in daily body weight gain when compared to lambs fed a traditional 40% concentrate: 60% roughage fodder diet in which *P. purpureum* is the only roughage fodder component.

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