INTAKE, DIGESTIBILITY AND PERFORMANCE OF LAMBS FED WITH DIETS CONTAINING CASSAVA PEELS

Consumo, digestibilidade e desempenho de cordeiros alimentados com dietas contendo casca de mandioca

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ABSTRACT

Sheep farming is designated to economic exploitation, and dry matter intake is the most important factor that influences the performance of animal, thus seeking alternative foods. This study aimed to evaluate the effects of inclusion levels of cassava peel on intake, digestibility and performance of feedlot lambs. We used 32 crossbred lambs Santa Inês uncastrated, mean body weight of 21 ± 1.5 kg. Treatments were arranged in a randomized design to animals, with inclusion levels of cassava peel (0, 10, 20, 30%) in the diet dry matter and forage cassava leaf hay. During 70 days, there have been weighing the food provided, leftovers, and animals, and feces collection. The intake of dry matter (DMI), organic matter (OMI), crude protein (CPI), ether extract (EEI), neutral detergent fiber corrected for ash and protein (NDIap), total carbohydrates (CTI), non-fiber carbohydrates (NFCI), total digestible nutrients (TDNI), as well as DMI and NDFap/kgCP, DMI and NDFIap/PC$^{0.75}$ levels have not been affected by the inclusion of cassava peel. Similar results for DM digestibility, NDF, CP, MO, CT and the TDN. DEE had a growing linear effect whereas DNFC presented a quadratic effect. Average daily gain (ADG), feed conversion (FC), initial body weight (BWinitial), final body weight (BWfinal), warm carcass weight (WCW) and warm carcass yield (WCR) showed no changes. It is concluded that the peel cassava may be included in diet until 30%, without change dry matter intake and animal performance.

Index terms: Average daily gain, nutrition, sheep.

RESUMO

A criação de ovinos é designada à exploração econômica,e a ingestão de matéria seca é o fator mais importante que influencia o desempenho animal, buscando, assim, alimentos alternativos. Objetivou-se avaliar os efeitos dos níveis de inclusão da casca da mandioca sobre o consumo, digestibilidade e desempenho de cordeiros confinados. Foram utilizados 32 cordeiros mestiços Santa Inês, não castrados, peso corporal médio de 21 ± 1,5 kg. Os tratamentos foram distribuídos em delineamento inteiramente casualizado aos animais, com níveis de inclusão da casca de mandioca(0, 10, 20, 30%) na matéria seca da dieta, e o volumoso o feno da parte aérea de mandioca. Durante 70 dias, realizaram-se pesagens dos alimentos fornecidos, sobras, e animais, e coleta de fezes. O consumo de matéria seca (CMS), matéria orgânica (CMO), proteína bruta (CPB), extrato etéreo (CEE), fibra em detergente neutro corrigida para cinza e proteínas (CFDNcp), carboidratos totais (CCT), carboidratos não fibrosos (CCNF), nutrientes digestíveis totais (CNDT), bem como CMS e FDNcp/kgPC, CMS e CFDNcp/PC^{0,75}não foram alterados pelos níveis de inclusão da casca de mandioca, resultados semelhantes para digestibilidade aparente MS, FDNcp, PB, MO, CT e os valores de NDT. A DEE teve efeito linear crescente e DCNF efeito quadrático. O ganho médio diário (GMD), conversão alimentar (CA), peso corporal inicial (PCi), peso corporal final (PCf), peso de carcaça quente (PCQ) e rendimento de carcaça quente (RCQ) não apresentaram alterações. Conclui-se que a casca da mandioca pode ser incluída na dieta até 30%, sem comprometer o consumo e desempenho dos animais.

Termos para indexação: Ganho médio diário, nutrição, ovinos.

INTRODUCTION

Besides contributing to income generation, sheep farming is an economic activity that sustains rural zone families, primarily in the Brazilian semiarid region. Despite this activity increases the consumption of sheep meat in large urban centers it is still poorly explored in certain regions. The sheep breeds raised for meat production grow faster and have a good carcass finishing; however, these are very demanding in terms of food supply and sanitary management. Despite having a carcass appearance that falls short of the expected by consumers, native breeds such as the crossbreed Santa Inês have a remarkable adaptability to the semi-arid conditions prevalent in northeastern Brazil (Araújo Filho et al., 2010).

The sheep meat market has stimulated the production of slaughter lambs, this is important to adapt the production systems. Yet, the intensive sheep industry

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Received in july 30, 2013 and approved in february 14, 2014

encounters obstacles related to feeding costs. Thus, cassava peel industry processing production of cassava flour represents economically viable and cassava peel a co-product with low amounts of protein and lots of fiber and energy, mainly used in feeding animals for fattening. Brazil is a major producer of cassava in the world, with 21milhões tons of planted roots, according to the Brazilian Institute for Geography and Statistics - IBGE (2013), the harvested area in Bahia state was 273/ha. In addition, the main residue of cassava industrialization for flour production is the cassava peel.

A good way to predict the effectiveness of feeding systems is the voluntary consumption of animals. According to Pereira et al. (2008), dry matter intake is the key factor that influences animal performance, since this is the whole point of access to the nutrients especially energy and protein which are necessary to meet the animals requirements. Thus, the physical and chemical characteristics of the food can positively or negatively affect the intake. Moreover, the digestibility coefficients of nutrients also influence the performance, as it allows calculating the apparent quantities absorbed from food in the gastrointestinal tract (Ítavo et al. 2002).This study was aimed at assessing the levels inclusion of cassava peel in the diets of feedlot lambs on intake, nutrient digestibility and animal performance.

MATERIAL AND METHODS

The experiment was conducted in Rural Family House (RFH)located in Novo Horizonte Farm, in the municipality of President Tancredo Neves, state of Bahia, from February to April 2011.

Thirty two used 32lambs, uncastrated crossbred Santa Inês lambs aged approximately six months, with initial body weight of 21 ± 1.5kg were used. The animals were identified with earrings and wormed. The animals were confined in 12m^2 individual stalls with concrete floor, fitted with drinkers and feeders.The animals were distributed in a completely randomized design with 8 replicates per treatment. The treatments consisted the addition of 0, 10, 20, and 30% cassava peel in dry matter of diet.

Cassava leaf hay was used as forage and the concentrate consisted of corn, soybean, cassava peel and a mineral mixture. The forage:concentrate ratio was 48:52. The diets were formulated so as to meet the nutritional requirements of animals, maintaining and daily gain of 0.2 kg/day. (Table 1).

Cassava leaf hay was granted by COOPATAN (Rural Farmers Cooperative of President Tancredo Neves), which has used the stems and leaves of cassava, making industrial drying. The cassava leaves were chopped in a mill with stationary blades and taken to a dryer whose heat was produced by firewood. Before cassava peel be used directly in the feed, was taken to oven drying. With 15% CP, the diets were formulated to be isoproteic (Table 2).

The experiment lasted 70 days, seven for adaptation to the facilities and experimental diets, and three periods of 21 days evaluation and collection data. The consumption patterns were adjusted by weighing the provided food and leftovers, considering 10% the offered amount. The diets were offered twice daily at 08:00 a.m. and 04:00 p.m. as a complete mixture, and water *ad libitum*.

Samples of the provided foods, leftovers and feces were weighed and placed in plastic bags, and then stored in a freezer at-5 °C. At the end of the experiment, the collected samples were heated in a forced ventilation oven at 55-65 ºC for 72 hours for determining the pre-dried matter. After that, the samples were ground in a Willey grinder equipped with 1 mm mesh sieves, and then packaged for laboratory analysis. Dry matter (DM), ether extract (EE),

Table 1 – Chemical composition of the diet ingredients based on dry matter (% DM).

Itens	Cassava leaf hay	Corn	Soybean meal	Cassava Peel
DM(%)	91.28	90.16	91.97	90.64
OM	92.40	98.38	93.57	98.00
CP	17.83	9.43	46.51	5.55
EE	4.77	2.22	2.34	0.67
NDF	67.32	12.53	21.39	22.65
FDA	56.62	2.13	6.27	14.36
Hemicellulose	10.70	10.40	15.12	4.65
Lignin	15.49	1.20	1.60	7.93

mineral matter (MM), crude protein (CP), acid detergent fiber (ADF) and lignin contents were determined using the methodologies described by Silva and Queiroz (2002). In turn, the levels of neutral detergent fiber (NDF) were estimated as proposed by Mertens (2002). The corrections to ash and protein contained in NDF were carried out as recommended by Mertens (2002) and Licitra, Hernandez and Van Soest, (1996).

As for the determination of dry matter intake and other components of the diets, the amounts of food offered were daily recorded while leftovers were weekly collected and heavy. Total carbohydrates (TC) have been estimated using the following equation, as proposed by Sniffen et al. (1992):

$$TC = 100 – (\%CP + \%EE + \%MM)$$

Non-fiber carbohydrate (NFC) contents were calculated as proposed by Detmann and Valadares Filho (2010):

$$NFC = 100 – MM – EE – NDFap - CP$$

Total digestible nutrients (TDN) were determined according to Weiss (1999), using the following equation:

$$TDN = DCP + DNDFap + DNFC + 2.25DEE$$

Where:DCP (digestible CP), DNDFap (digestible NDFap), DNFC (digestible NFC) and DEE (digestible EE).

Between the 30° and 34° days of the experimental period, feces samples were collected directly in the rectum ampoule. Sampling followed this distribution: 30° day, 8:00 a.m. and 02:00 p.m.; 31° day, 10:00 a.m. and 04:00 p.m.; 32° day, 12:00 and 06:00 p.m.; 33° day, 02:00 p.m. and 08:00 p.m. and; on the 34° day, 04:00 p.m. and 10:00 p.m., as proposed by Ferreira et al. (2009). The samples were stored in a freezer (-5 °C). After the end of the experimental period, the stools were dried in an oven with forced ventilation (60 °C - 72 h) and processed in a Willey Mill equipped with 1 mm stationary blades and then proportionally composed based on the dry air weight per animal/period, and stored for later analysis. Neutral

Table 2 – Percentage composition of the diet ingredients in dry matter.

	Cassava peel levels (%)			
Itens	0	10	20	30
Cassava leaf hay	48.34	48.34	48.34	48.34
Corn	47.79	36.49	25.10	14.00
Soybean meal	3.14	4.44	5.77	6.83
Cassava Peel	0.00	10.00	20.00	30.00
Mineral Salt	0.48	0.48	0.48	0.48
Dicalcium phosphate	0.18	0.24	0.30	0.34
Chemical composition				
DM(%)	90.30	90.84	91.84	90.74
OM(DM)	94.92	94.47	94.51	94.28
CP (DM)	15.49	15.29	15.44	15.75
EE	3.17	3.02	2.81	2.71
NDF	42.94	43.11	43.46	47.62
ADF	24.79	24.63	25.42	28.11
NDFap	38.19	39.38	41.17	40.36
Lignin	7.94	9.34	9.62	10.97
NFC	38.68	36.96	34.78	35.51
TC	76.87	76.35	75.95	75.86

Assurance levels (nutrient/kg): Calcium-150g; sulfur-12g; phosphorus-65g; magnesium-6.000mg; sodium-107g; copper-100mg; cobalt-175mg; iron-1000mg; maximum fluor-650mg; iodine-175mg ; manganese-1440mg; selenium-27mg and zinc-6000mg.

detergent fiber indigestible (iNDF) has been used as an internal indicator for estimating thedaily fecal excretion in the samples provided, leftovers and feces. To this end, an *in situ* digestibility procedure has been adopted, for 288h, as suggested by Valente et al (2011).

The lambs were weighted at the beginning of the experiment and every 21 days for weight control. At the end of the experimental period, weighing was conducted so as to verify the average daily gain. The lambs have gone through a fasting period of 16 hours and then weighed to verify the fasting body weight (FBW). Next, the animals were slaughtered to obtain the warm carcass weight (WCW) and calculate the warm carcass yield (WCY) through the formula (WCY = WCW/WCA* 100).

The statistical analyzes of data were carried out using the Statistical and Genetics Analysis System (SAEG) through analysis of variance and regression at a significance level of 5%.

RESULTS AND DISCUSSION

The intake of DM and nutrients were not affected (P>0.05) by cassava peel inclusion, as shown in table 3.

The average dry matter intake was 0.848 kg/day. The fiber contents in the experimental diets were increasing (Table 2), but did not affect the intake parameters of DM and OM, which are deemed important in animal performance. According to Mertens (1994), diets with high levels of energy consumption is determined by meeting the nutritional requirements of the animal and diets with low energy levels the limiting factor is the physical capacity for intake. Yet, it is positively correlated when energy is the limiting factor. The great potential of NDF degradation from cassava peel was probably the key determinant that prevented the fiber source from causing physical limitations to DMI.

A minor intake was obtained by Faria et. at. (2011), in a work involving different methods of processing cassava peel, where the average dry matter intake ranged from 426.71 to 478.08 g/day. In a study involving cassava in the diets of feedlot sheep, Conceição et. al. (2009) have noted that the voluntary intake of dry matter and organic matter were not affected (P>0.05) by the inclusion of up to 48% in the diet.

The crude protein intakes (CPI) expressed as kg/day from animals fed different peel cassava levels have shown an average value of 0.132 kg/day. The non-effect for DMI has affected the results in CPI, which bear direct relationship. Furthermore, the diets were isoproteic and have not therefore contributed to the variation of results. Lower CPI values were verified by Menezes et. al. (2004), who worked in the replacement of corn by cassava peel in complete mixed feeds for goats, verified crude protein intakes of 127.13; 120.14; and 118.30 g/day for cassava peel levels of 0.33% and 66%.

The EEC averaged 0.024 kg/day, with no influence of cassava peel, as the contents of EE the experimental diets were close, not influencing the EEC.

There was no effect (P > 0.05) for intake NDFap because this result followed the behavior of the DM. In the knowledge that the energy of food comes from organic compounds such as CP, EE, NFC and also fibrous fractions, there was no effect regarding the intake of TDN; thus, the similar levels of such variables in the diets may have contributed to this result.

The results showed that there was no difference (P>0.05) among the diets for DDM, DNDFap, DCP, DOM, DTC and TDN values, presented in table 4.

With a mean value of 67.36%, DDM was not influenced by the inclusion of cassava peel. In the evaluation of corn replacement by cassava in the diet of goats, Menezes et al (2004) have observed that the digestibility coefficient of DM ranged from 70.32 to 59.01%. In a study assessing the *in situ* rumen degradability. On the other hand, DEE showed a growing linear effect with the inclusion of cassava peel. Such behavior may be the result of a higher digestion rate ofEE from cassava peel as compared to other foods present in experimental diets (Table 2).

A quadratic effect was observed for DNFC, with a maximum value of 94.90 for the level of 21.33% cassava peel. This can be explained by the fact thatstarch cassava peelis of better digestibility than that of corn. According to Zeoula et al. (1999) the rumen degradability of cassava starch is higher(79.1%) as compared to that of corn (57.8%).

TDN content has not varied amongthe diets (P>0.05), with a mean value of 64.43% (Table 4), which is close to meet the nutritional requirements of sheep (66.01%), according to the National Research Council-NRC (2007).

With respect to the performance parameters, it has been found that ADG, FC, FE, BW initial, BW final and WCY were not significantly affected (P>0.05) by the inclusion of cassava peel.

A mean value of 0.152 kg/day has been verified for ADG. Corroborating this work, witha study by Faria et al. (2011), addressing the various processing methods of cassava peel for the diet of sheep has found an average weight gain of 0.150 kg per day.

Table 3 – Nutrient intake by lambs fed diets containing different levels of cassava peel.

	Treatments								
	0%	10%	20%	30%			P - Value		
Itens	Intake (kg/day)				SE	Average	L	Q	C
DMI	0.884	0.881	0.831	0.798	30.16	0.848	0.261	0.810	0.807
OMI	0.841	0.833	0.786	0.754	28.57	0.803	0.238	0.825	0.834
CPI	0.141	0.137	0.131	0.121	4.63	0.132	0.125	0.708	0.965
EEI	0.028	0.027	0.023	0.020	0.91	0.024	0.140	0.501	0.751
NDFIap	0.268	0.331	0.321	0.304	14.62	0.306	0.461	0.357	0.613
TCI	0.675	0.669	0.628	0.603	22.85	0.643	0.218	0.849	0.804
NFCI	0.361	0.338	0.325	0.329	10.65	0.338	0.265	0.521	0.944
TDNI	0.798	0.740	0.709	0.653	30.07	0.725	0.095	0.975	0.849
	Intake (% body weight)								
DM	3.157	3.141	3.187	3.250	0.10	3.180	0.724	0.847	0.965
NDFap	1.116	1.175	1.230	1.234	0.04	1.188	0.280	0.744	0.907
	Intake ($g/kg^{0.75}$)								
DM	73.28	72.13	71.92	72.21	2.23	72.38	0.866	0.873	1.000
NDFap	25.67	27.02	27.75	27.44	0.93	26.97	0.471	0.656	0.957

Dry matter intake (DMI), organic matter intake (OMI), crude protein intake (CPI), ether extract intake (EEI), intake of neutral detergent fiber corrected for ash and protein (INDFap), total carbohydrates intake (TCI), non-fiber carbohydrates intake (NFCI) and total digestible nutrients (TDNI). SE (standard error), Linear (L), Quadratic (Q), Cubic (C).

Table 4 – Apparent digestibility of nutrients and total digestible nutrients in lambs fed containing different levels of cassava peel.

	Diets						P-Value		
Items	0%	10%	20%	30%	SE	Average	L	Q	C
DDM	66.28	66.46	70.53	66.19	0.786	67.36	0.593	0.161	0.091
DNDFap	48.37	43.65	52.92	41.86	1.445	46.70	0.433	0.281	0.013
DCP	52.54	53.96	58.57	59.56	1.282	56.15	0.076	0.944	0.628
DEE	61.21	61.14	61.24	69.24	1.247	63.20	[1]0.019	0.080	1.000
DOM	66.77	67.05	71.09	67.03	0.790	67.98	0.502	0.180	0.104
DTC	69.28	69.48	73.51	68.05	0.783	70.08	0.965	0.081	0.067
DNFC	87.98	94.09	94.95	94.52	0.720	92.88	0.004	[2]0.033	0.550
TDN	62.97	63.20	66.86	64.72	0.791	64.43	0.216	0.461	0.550

Apparent dry matter digestibility (DMD), neutral detergent fiber corrected for ash and protein (DNDFap), crude protein (DCP), ether extract (DEE), organic matter (DOM), total carbohydrates (DTC), non-fiber carbohydrates (DNFC) and total digestible nutrients (TDN); L (linear); Q (quadratic); C (cubic); SE (standard error); [1]$\hat{Y}= 0.2418x + 59.581$ ($r^2 = 0.6025$); [2]$\hat{Y}=-0.0163x2 + 0.6952x + 88.175$ ($r^2 = 0.9759$)

Feed conversion is defined as the DMI:ADG ratio, representing the efficiency with which the animal converts food in to protein of animal origin. Hence, once DMI and ADG were not affected by cassava peel, these have contributed to the results of feed conversion, which were not affected (P>0.05) by the inclusion the same(Table 5).

Table 5 – Performance of lambs fed diets containing different levels of cassava peel.

	Diets						Value:P		
Itens	0%	10%	20%	30%	SE	Average	L	Q	C
ADG(kg)	0.149	0.154	0.153	0.153	0.040	0.152	0.907	0.903	0.939
FC (kg)	6.690	6.150	5.860	5.480	0.072	6.040	0.293	0.921	0.925
FE (kg)	0.167	0.170	0.179	0.190	0.052	0.176	0.355	0.823	0.944
BWi (kg)	21.95	23.20	21.50	20.38	0.845	21.75	0.406	0.492	0.647
BWf (kg)	31.33	32.89	30.75	30.00	1.732	31.24	0.421	0.496	0.502
WCW (kg)	15.17	15.17	13.81	13.30	0.391	14.36	0.056	0.744	0.531
WCY (%)	45.53	46.05	44.13	44.41	0.358	45.03	0.110	0.866	0.160

Average daily gain (ADG), feed conversion (FC), feed efficiency (FE), initial body weight (BWi), final body weight (BWf), warm carcass weight (WCW), warm carcass yield (WCR); SE (standard error);L (linear); Q (quadratic); C (cubic).

The mean value found for WCY was 45.03% (Table 5).The similarity of body weight, associated with a similar age have possibly prevented that the carcass yield was affected; the reason is that, according to Cezar and Sousa (2007), amongst the factors intrinsic to animals, body weight and age are probable the ones that most influence the carcass yield. According to Macedo, Siqueira and Martins (1999), the carcass yield of sheep may vary from 40 to 50%. Lower carcass yield values (39.46%) were reported by Furusho-Garcia et al. (2010) in a study involving Santa Inês sheep slaughtered at an average weight of 38 kg.

CONCLUSION

The peel of cassava can be included in the diet up to 30% with no change on intake and animal performance.

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