Journal of Animal and Veterinary Advances 6 (10): 1190-1193, 2007
ISSN: 1680-5593

Studies on the Cell Wall Digestibility in Pigs Fed Leucaena (*Leucaena leucophala* (Lam.) de Wit) Leaf Meal

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Abstract: Six crossbred castrate male pigs weighing on average 55 kg each were randomly allocated to 3 diets according to a duplicate 3×3 Latin square design to study digestion characteristics of cell wall fractions as determined by 0, 10 and 20% sun-dried leucaena (*Leucaena leucocephala* Lam. de Wit) Leaf Meal (LM) in diets based on sugar cane molasses type B and soybean meal. A significant ($p<0.01$) decrease in lignin and cell content (1-NDF) digestibility was observed by increasing the level of LM in the diet. There was no treatment effect on digestibility of crude fibre and other detergent fractions of fibre. A significant interdependence was found between faecal fresh material output and WHC ($p<0.001$, $R^2 = 0.896$). It could be suggested that a moderate increase in LM up to 20% in the diet, should not determine a marked, deleterious effect on fibrous fraction digestibility as measured at the rectal site of growing pigs.

Key words: Leucaena leaf meal, cell wall, digestibility, pig, cell content, water holding capacity, digesta flow

INTRODUCTION

The use of alternative sources of nitrogen for pigs is an important objective of research. In this connection *Leucaena leucocephala* (Lam.) de Witt is a tropical shrub which should be used for feeding pigs as a source of nitrogen (Pérez, 1997). Although, the digestion of leucaena fibre and its effect on digesta flow has not been thoroughly studied in pigs, some digestibility trials have suggested that the fibre content of Leucaena Meal (LM) is likely to be the main constraint for an efficient utilization of this type of feed (Santos and Abreu, 1995). On the other hand it is also known that sugar cane molasses are poor in cell wall and protein nitrogen. In this regard, the adverse effects associated with the presence of high amount of fibre in the diet may no be a serious problem for pigs fed this type of diet.

The aim of the present research was to study some characteristics of the digestion of several fibre fractions and the digesta flow in pigs, fed graded level of leucaena foliage meal.

MATERIALS AND METHODS

The LM was obtained after cutting branches from a leucaena plantation (cv, ipil-ipil). The branches were chopped, spread over a plate and sun dried for 3-4 days. As a result of a natural shedding process, only dry leucaena leaves were collected, therefore discarding all type of stalks. Sugar cane molasses type B was obtained from a Cuban sugar factory, Havana and resulted from the second sugar extraction, after a clarifying process conducted with a Cuban natural zeolite (Macías and Ly, 1995). Three diets were formulated with soybean meal, sugar cane molasses type B and different levels of LM. The composition and nutritive value of the experimental diets is presented in Table 1.

Table 1: Characteristics of the experimental diets

	Leucaena leaf meal in diet (%)		
Ingredients (%)	0	10	20
Soybean meal	30.2	24.5	20.7
Sugar cane molasses type B	66.3	61.9	56.1
Leucaena leaf meal	0	10.0	20.0
Premix[1]	3.5	3.6	3.2
Chemical composition (% dry basis)			
Organic matter	95.3	95.8	96.3
Crude protein	14.0	13.9	13.9
WHC[2], g kg^{-1} DM	1.51	2.18	3.03
Digestibility (%)			
Dry matter	82.3	82.9	84.6
Organic matter	95.3	95.8	96.3

[1] Content (kg^{-1}); vitamin A, 600 IU; vitamin D_3, 160 IU; vitamin E, 10 mg; vitamin B_1, 2 mg; vitamin B_2, 3 mg; vitamin B_6, 15 mg; vitamin B_{12}, 0.025 mg; panthotenic acid, 5 mg; choline chloride, 300 mg; menadione sodium bisulphate, 2 mg; folic acid, 0.5 mg; cobalt, 0.4 mg; iron, 10 mg; iodine, 0.5 mg, [2]WHC, water holding capacity

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Table 2: Fibre fractions of the experimental diets

Composition (%)	Leucaena leaf meal in diet (%) 0	10	20
Crude fibre	1.81	7.20	10.81
NDF	3.74	9.36	14.96
ADF	1.76	5.44	9.11
Lignin	0.42	0.98	1.54
Hemicellulose	1.98	3.92	5.85
Cellulose	1.35	4.44	7.57
1 - NDF	96.26	90.64	85.04

The characterization of the fibre fraction of diets is present in Table 2.

Six crossbred castrate male pigs weighing on average 55 kg were allocated to each of 3 treatments according to a duplicated 3×3 Latin Square design. The animals were individually penned and fed twice at 9.00 and 13.00 h. The level of daily feed intake was 0.1 kg DM, per kg $W^{0.75}$. The ration was mixed with water to attain approximately 40% DM to facilitate mixing and consumption by pigs. Drinking water was provided ***ad libitum***. The animals were adapted to the liquid diet containing soybean meal and sugar cane molasses for one week and then assigned to the experimental diets. After 7 days, a faecal grab sample was obtained from every fasting animal, in the morning; then the pigs were weighed and the next diet was supplied.

Feed and faecal samples were analyzed for NDF, ADF, lignin, cellulose (FAD-lignin), hemicellulose (NDF-ADF) and cell content (1 - NDF) by the Van Soest *et al*. (1991) technique of fibre fractionation by detergent solutions. Acid insoluble ash was estimated as outlined by Van Keulen and Young (1977). Crude fibre was determined in both feeds and faeces following AOAC (1995) recommendations. In relation to the Water Holding Capacity (WHC), the analysis was made according to Kyriazakis and Emmans (1995), by the method of centrifugation.

Apparent rectal digestibility indicators for the different fibrous fractions was determined by the indirect method and calculated according to Van Keulen and Young (1977) recommendations.

Treatment differences were determined by analysis of variance and means separated by Duncan´s multiple range test (Steel *et al*., 1997). A general linear model was employed through the Minitab software (Ryan *et al*., 1985). A Pearson matrix correlation analysis was established among the WHC and fibrous fraction content of diets, then a linear association of Water Holding Capacity (WHC) and the faecal flow of fresh material was established by linear regression analysis.

RESULTS AND DISCUSSION

A significant increase ($p<0.05$) in daily flow of fresh and dry faecal material was found with the inclusion of

Table 3: Daily faeces output in pigs fed leucaena leaf meal

	Leucaena leaf meal in diet (%) 0	10	20	SEM±
Faeces output, g kg^{-1} DM intake				
Fresh material	291.1^{a}	511.3^{ab}	788.5^{b}	107.0*
Dry material	65.7^{a}	113.5^{ab}	180.1^{b}	25.1*
Water	225.4^{a}	397.8^{ab}	608.4^{b}	90.8*
Water:DM in faeces	3.44	3.50	3.42	0.28

*$p<0.05$, ^{ab} Values within the same row which do not share a common superscript differ significantly ($p<0.05$)

Table 4: Correlation matrix of digesta flow and diets characteristics

	WHC	DF	CF
DF	0.946		
CF	0.983	0.943	
NDF	0.998	0.948	0.994

$p<0.001$ for $r = 0.620$, DF is digesta flow, in fresh basis, whereas CF, NDF and WHC expresses crude fibre, neutral detergent fibre and water holding capacity

20% LM in diet. There were not differences between control and 10% of inclusion LM in daily faeces output. The diet with a highest amount of LM determined an increase in daily flow of water (Table 3). In this respect, Ly *et al*. (1995) found that ileal and faecal flow of fresh material and water increased in diets with Jerusalem artichoke tubers included in diets formulated with sucrose. The same pattern of faecal flow was found in growing pigs fed diets containing other tropical tree foliages, such as Albizia lebbeck and Guazuma ulmifolia (Díaz *et al*., 2005).

A significant interdependence ($p<0.001$) was observed in this study between rectal flow of materials and diets characteristics (Table 4). It has been suggested that diets with a high WHC value may determine an increase in faecal fresh material output (Decuypere *et al*., 1994). On the other hand, dietary fibre can influence bulking characteristics in faeces (Moeser and Van Kempen, 2002). In this connection, Bach Knudsen and Hansen (1991) suggested that a bulking effect is related to NDF in the diet of pigs. On the other, hand Chiv *et al*. (2003) observed that an increase in faecal fresh material and water output was associated to an increase in the fibrous fraction of diet, as a result of its bulking characteristics. In fact, the herein found interdependence, as it was previously obtained by Chiv *et al*. (2003), supports the working hypothesis that certain physico-chemical properties of fibrous material in the diet are responsible of faeces bulkiness in pigs (Decuypere *et al*., 1994; Leterme *et al*., 1998). Then it follows that it could be assumed that WHC could be used to predict an increase in faecal output of materials in pigs. The results reported in the present examination do compel to search for further evidences related to these relationships.

Interestingly, a significant relationship was found between faecal fresh material output and WHC ($p<0.001$, $R^2 = 0.896$). This association could be expressed by the following equation:

Table 5: Rectal digestibility of cell wall in pigs fed leucaena leaf meal

	Leucaena leaf meal in diet (%)			
Digestibility (%)	0	10	20	SEM±
Crude fibre	58.9	72.9	68.0	3.0
NDF	60.6	55.4	50.7	3.59
ADF	44.1	44.5	45.8	2.61
Lignin	43.6[a]	13.7[b]	7.9[c]	5.38*
Hemicellulose	75.0	70.4	70.1	3.15
Cellulose	46.5	52.1	51.5	4.86
1 - NDF	94.7[a]	91.8[ab]	87.5[b]	1.35**

*p<0.05; ** p<0.01, [ab] Values within the same row which do not share a common superscript differ significantly (p<0.005)

$$\ln y = \ln 4.615 + 0.715\, x,$$

Where, y and x express fresh material output and WHC, in g kg^{-1} DM intake and g H_2O g^{-1} DM, respectively.

The digestibility of cell content decreased at the higher level of LM (Table 5) as it has been reported in several occasions for several organic matter components in diets containing graded levels of by-products rich in fibre (Bach Knudsen and Jorgensen, 2001; Le Goff *et al.*, 2002; Moeser and Van Kempen, 2002; Hansen *et al.*, 2006; Wilfart *et al.*, 2007). On the other hand, the inclusion of LM in the diet determined a different response in the digestibility of lignin (p<0.05), as compared to other fibrous fractions. In fact, the other cell wall digestibility indicators were not affected by the inclusion of LM in the diet (p<0.01) and this probably contributed to a lack of negative influence of LM on DM and organic matter digestibility of the diet (Table 1). It is possible that according to the herein presented data, the microflora of digestive tract of pigs was highly adapted to this type of diets since in fact the digestion of different fibre fractions may decrease with the inclusion of several tropical fibre sources in the feed (Ly *et al.*, 1997; García and Ly, 2000; Domínguez and Ly, 2004). On the other hand, perhaps the use of relatively young leaves of leucaena, without any lignified plant structure, since the foliage was obtained from a periodically cut plantation, could contribute to explain the results obtained in the current evaluation.

According to results derived from the present study, it could be suggested that a diet exhibiting a high WHC should determine an increase in fresh material output and then it might be assumed that WHC could be used to predict increases in faecal output in pigs fed bulked rations similar to those used in the current investigation. Besides, it could be suggested that a moderate increase in LM up to 20% in the diet, should not determine a marked, deleterious effect on fibrous fraction digestibility as measured at the rectal site of growing pigs fed sugar cane molasses as the main component of the diet.

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