

water spinach and fresh cassava leaves

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Effect of water spinach and fresh cassava leaves on intake, digestibility and N retention in growing pigs

The Center for Livestock and Agriculture Development (CelAgrid-UTA Cambodia) studied the effect of water spinach and fresh cassava leaves, fed alone or mixed together, on intake, digestibility and N retention of growing pigs fed a low-protein, basal diet of broken rice... (with the permission of Livestock Research for Rural Development).

The experiment was conducted in the Center for Livestock and Agriculture Development (CelAgrid-UTA Cambodia). Three Local x Large White or Duroc male pigs weighing on average 15.1 kg were allotted at random to three diets to study the effect on digestibility and N retention of water spinach and fresh cassava leaves, or a mixture of the two, as supplements to broken rice. The design was a 3x3 Latin square with periods of 14 days. Foliage was harvested daily from a late maturing cassava variety (12-15 months) beginning 5 months after planting. Fresh cassava leaves and fresh water spinach were chopped into small pieces and fed ad libitum. Broken rice was restricted at a level of 2% of body weight (DM basis). The HCN content of the fresh cassava leaves was 508 mg/kg DM resulting in an intake of 9.4 mg HCN/kg live weight. During the entire trial the pigs were in a positive body weight balance and there were no symptoms of toxicity from feeding fresh cassava leaves. Total DM intake, digestibility of DM, OM, N and crude fiber, and N retention, were higher with fresh water spinach and the mixture between fresh water spinach and cassava leaves, as compared with fresh cassava leaves alone. It is concluded that: fresh cassava leaves can be fed at 41% of the diet DM with no apparent signs of toxicity; fresh water spinach is more palatable than cassava leaves as reflected in higher total DM intake and the proportion of the diet (47%) provided by the leaves.

Key words

: broken rice, digestibility, fresh cassava leaves, N retention, pigs, water spinach

Introduction

Monogastric animals play an important role in agricultural activities in rural areas in Cambodia. On average, a farmer raises 2 to 5 heads of pigs (local or crossbred). The major problem in pig production is the lack of protein because protein-rich feed resources are scarce and, if available, the prices are often prohibitive. There is a need to identify feeds, which can compensate for these deficiencies.

Water spinach (*Ipomoea aquatica*) is a water plant. It is cultivated for human food and used for pigs and other animals in Cambodia. It does not appear to contain anti-nutritional compounds and has been used successfully for growing pigs as the only source of supplementary protein in a diet based on broken rice (Ly 2002). In that research there was a significant response in growth rate and feed conversion to supplementary DL-methionine. Prak Kea et al (2003) reported a linear increase in growth rates in pigs fed water spinach, palm oil and broken rice when up to 6% fish meal replaced equivalent amounts of water spinach, which they attributed to an improved amino acid balance, especially in terms of the sulphur-rich amino acids.

Cassava (*Manihot esculenta* Crantz) is a widely grown crop in many tropical countries (Calpe

1992). Traditionally it is cultivated for root production, but recently attention has focused on managing it as a semi-perennial forage with repeated harvesting at 2-month intervals (Preston 2001). In this system, when the cassava is fertilized with high levels of organic manure, annual protein yields can reach 3 to 4 tonnes/ha.

Nutritional experiments with pigs using cassava leaves have concentrated on processing the leaves by ensiling (Ly et al 2001), as this is a safe way of reducing the concentration of the precursors of HCN, which are the toxic elements in fresh cassava leaves. Sun drying is even more effective than ensiling as a means of reducing the risk from HCN toxicity (Oke 1994). However, this is almost impossible to do in the rainy season and is also time consuming. Ensiling the leaves can be done all-year round but requires infrastructure and is also a laborious procedure. If cassava leaves could be fed fresh to pigs this would simplify the management considerably.

The protein in cassava leaves has been reported to be rich in lysine but limiting in methionine (Eggum 1970). Water spinach also appears to be limiting in methionine in view of the growth response when synthetic DL-methionine was added to a diet in which water spinach provided most of the protein (Ly 2002). Mixing two sources of leaves as sources of protein may be beneficial in view of possible complementary effects of the two arrays of amino acids.

The aim of the present experiment was to study the effect of water spinach and fresh cassava leaves, fed alone or mixed together, on intake, digestibility and N retention of growing pigs fed a low-protein, basal diet of broken rice.

Materials and Methods

Location and climate

The experiment was carried out from 5 September to 11 October 2004 at the Center for Livestock and Agriculture Development (CelAgrid-UTA Cambodia), located in Kandal village, Rolous Commune, Kandal steung district, Kandal province about 25km from Phnom Penh City, Cambodia . During the trial, the temperature was about 27 °C in the morning, 31 °C in the middle of the day and 30 °C in the evening.

Experimental feeds

The daily dry matter (DM) allowance was calculated at 4% of the body weight. The broken rice was restricted to 2% (DM basis) of live weight, so as to stimulate the pigs to eat the forages. DL-methionine was included at the level of 0.3% (in DM). Fresh cassava leaves were harvested everyday in CelAgrid-UTA Cambodia, beginning at 5 months after planting the cassava. Stems and petioles were removed from the leaves and then the leaves were chopped into small pieces and offered immediately. Water spinach was purchased from the farmers near the center and was chopped into small pieces and offered immediately at the same time as the fresh cassava leaves. The broken rice was purchased from a local rice mill near CelAgrid. Data on composition of the feeds are in Table 1.

Table 1. Chemical characteristics of the ingredients of the diets

Dry matter, %	8.1 2	30. 6	86. 7
As % of DM			
Ash	13. 3	3.4 8	0.5 3
N	5.0 5	3.9	1.2 2
CP (N*6.25)	31. 6	24. 4	7.6 1
Crude fibre	15. 8	9.2 8	-
HCN, mg/kg DM	-	507	-

Photo 1: The metabolism cage used in the experiment



Treatments and design

There were three treatments:

1. FC: Fresh cassava leaves
2. WS: Water spinach
3. WSFC: Mixture between fresh water spinach and fresh cassava leaves (50:50 DM basis)

The experiment was done according to a 3*3 Latin Square arrangement of the 3 dietary treatments with 3 crossbred (Local x Large White or Duroc) young male pigs weighing on average 15.1 kg. The animals were housed in metabolism cages during the whole trial (36days). The metabolism cages (80 x 80cm) were built to allow the quantitative collection of faeces and urine (Photo 1). The characteristics of the cages have been described elsewhere (Chhayty et al 2003ab). The metabolism cages were installed in an open stable. Each experimental period consisted of 12 days; 7 days to adapt to the diets followed by another 5 days for collection of faeces, urine and feed refusals.

Table 2. Experimental layout

1	WS	FC	WSF C
2	WSF C	WS	FC
3	FC	WSF C	WS

The pigs were fed thrice daily with equal rations at 8:00 am, 12:00 am and 3:00 pm. The fresh cassava leaves, fresh water spinach or mixture were mixed with the other components of the ration (broken rice, premix and methionine). The mixture of leaves was in the ratio 35 of cassava leaves and 65 of water spinach (fresh basis). Water was permanently supplied through drinking nipples. The animals were weighed at the beginning of the trial and every 12 days.

Data collection

Feed refusals and faeces were collected every day and were kept frozen in plastic bags until analysis. A representative sample was obtained from every treatment. At the end of each period, feed refusals and faeces were mixed thoroughly by hand and then homogenized in a coffee grinder, prior to taking representative samples that were analyzed for DM, N, crude fibre, HCN and ash. Urine was collected in a plastic bucket to which sulphuric acid was added to maintain the pH below 4.0. The volume of urine was measured every day and at the end of each period a sample was analyzed for N.

Chemical analyses

Chemical analyses of the feed ingredients and faeces were undertaken following the methods of AOAC (1990) for ash, N and crude fibre. The DM content was determined using the microwave method of Undersander et al. (1993). Fresh faeces were analyzed for pH with a glass electrode. The N content of urine and HCN in fresh cassava leaves were determined by the AOAC (1990) procedures.

Statistical analyses

The data were subjected to analysis of variance according to the general linear model of the Minitab software (Minitab release 13.31, 2000). Sources of variation were pigs, periods, treatments and error.

Results and discussion

During the whole trial the pigs gained weight and there were no symptom of intoxication due to the fresh cassava leaves. The urine from the pigs fed fresh cassava leaves had a darker red colour compared with urine from pigs fed water spinach (Photo 2).

Photo 2: Characteristic of urine in pigs fed fresh cassava leaves (FC), fresh water spinach (WS) or a mixture of the two (WSFC)



All the broken rice was consumed. Total voluntary feed intake was higher on the two diets containing water spinach compared with only cassava leaves (Table 3). The proportion of the total diet in the form of foliage was highest with water spinach alone and lowest when cassava leaves alone were the source of foliage.

Table 3: Mean values of feed intake for pigs fed fresh cassava leaves (FC), water spinach (WS) or a mixture of the two (WSFC), as supplements to broken rice

Intake, g DM/day					
Broken rice	309	318	309	1.14	0.001
Cassava leaves		247	165	13.1	0.001
Total DM	616	579	606	13.6	0.155
Water spinach	292		104	10.0	0.001
DM, g/kg live weight	36.2	33.0	37.3	0.91	0.006
Foliage, % total intake	47.1	41.6	44.0	1.31	0.019

Table 4: Mean values for intake of crude protein and crude fibre in pigs fed fresh cassava leaves (FC), water spinach (WS) or a mixture of the two (WSFC), as supplements to broken rice

Crude protein			
Intake, g/day	116	96.6	84.3
% in DM	18.8	15.9	14.6
Crude fibre			
Intake, g/day	46.3	31.8	22.9
% in DM	7.51	5.24	3.96

HCN		83.9	125
mg/day			
mg/kg LWt		5.2	7.4
mg/kg DM		138	217

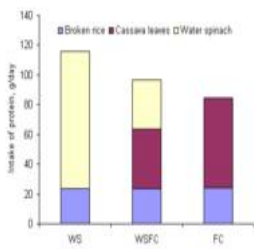


Figure 1: Intake of crude protein from dietary components

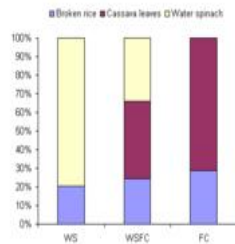


Figure 2: Proportion of dietary crude protein from dietary components

Faecal characteristics in pigs fed fresh cassava leaves, fresh water spinach

The dry matter content of the faeces was highest when the pigs were fed fresh cassava leaves and lowest for those fed water spinach (Table 5). Faecal pH tended to be higher for pigs fed only the water spinach as supplement.

Table 5. Faecal characteristics in pigs fed fresh cassava leaves and water spinach

	WS	WSFC	FC	SEM	P
Faecal pH	6.48	6.27	6.24	0.07	0.053
DM, %	19.8	27.0	22.7	0.19	0.001
Faecal excretion, g/kg DM intake					
Fresh material	507	702	708	47.8	0.007
Dry matter	101	185	159	10.7	0.001
Water	407	517	549	37.3	0.026

Nutrient digestibility

Digestibility of DM, OM, N and crude fiber decreased as cassava leaves replaced the water spinach (Table 6; Figure 3).

Table 6: Mean values of nutrient digestibility in pigs fed broken rice supplemented with fresh cassava leaves (FC), water spinach (WS) or a mixture of the two (WSFC)

Dry matter	89.9	81.5	84.1	1.07	0.001
Organic matter	90.6	81.7	84.8	1.02	0.001
Nitrogen	82.	60.2	72.2	1.88	0.001
Crude fibre	81.26	58.56	71.20	2.34	0.001

N balance

Daily N retention was lowest but the proportion of digested N that was retained was highest when the protein supplement was only cassava leaves (Table 7).

Table 7: Mean values for N retention in pigs fed broken rice supplemented with fresh cassava leaves (FC), water spinach (WS) or a mixture of the two (WSFC)

N balance, g/day					
Intake	19.6	13.7	16.4	0.49	0.001
Faecal excretion	3.26	5.18	4.61	0.37	0.002
Urinary excretion	6.12	1.13	1.80	0.44	0.001
N retention					
g/day	10.3	7.36	9.96	0.47	0.001
% of N intake	53.6	51.6	60.5	2.23	0.020
% of digested N	64.9	85.6	83.6	1.84	0.001

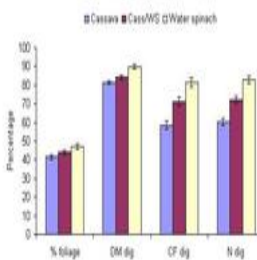


Figure 3: Mean values for DM intake of foliage as % of total intake, digestibility of DM, crude fibre and nitrogen, in pigs fed broken rice and fresh cassava leaves, water spinach or a mixtures of the two foliages

Discussion

The reduction in voluntary intake when fresh cassava leaves replaced water spinach could have been due to the lower digestibility of the diet especially the protein component. Other factors, such as the higher fibre content of cassava leaves, compared with water spinach, and the presence of cyanogenic glucosides and tannins, could be expected to reduce the voluntary feed intake. According to Ravindran et al (1987), the bitter taste of the leaves could negatively influence their intake by pigs. DM intake as percentage of live weight (3.3%) was similar to that reported by Du Thanh Hang (2005) (range of 2.7 to 3.3%), for crossbred pigs fed a 2:1 mixture of ensiled cassava root and rice bran and fresh cassava leaves that had been washed prior to feeding. It was higher than the values reported by Nguyen Duy Quynh Tram (2003) and Bounhong et al (2003) (2.6 and 3.11%, respectively), who used the same diet as in the present study. However, a much higher intake (4.4% of live weight) was recorded for pigs fed broken rice and cassava leaves that had been ensiled before feeding (Chhay Ty et al 2003a). It would appear that ensiling the leaves increases their palatability; however, a comparison of fresh versus ensiled leaves in the same experiment does not appear to have been made.

The reported toxic levels of HCN (mg/kg live weight) for pigs are 1.4 (Getter and Baine 1938), 2.1 to 2.3 (Johnson and Ramond 1965), 4.4 (Butler 1973) and 3.5 (Tewe 1992). In the present study the HCN intakes were much higher (5.1 and 7.4 for the WSFC and FC diets, respectively). Du Thanh Hang (2005) recorded even higher intakes (from 6.0 to 15 mg/kg live weight) when feeding fresh cassava leaves with ensiled cassava root and rice bran. However, apart from the red colour of the urine (observed also by Du Thanh Hang 2005), there were no signs of toxicity in the pigs fed HCN levels from 5.1 to 7.4 mg/kg live weight (present study) and even 15 mg/kg live weight (Du Thanh Hang 2005).

The digestibility coefficient for DM for the FC diet (82%) was higher than the value of 77% reported by Chhay Ty et al (2003a) when the leaves were ensiled. Conversely, the digestibility of N was lower (60% in this experiment) compared with the data (69%) of Chhay Ty et al (2003a) with ensiled leaves. It can be expected that the fermentation taking place during the ensiling process could make the nitrogenous compounds more available to digestive enzymes. Comparisons of digestibility with the data of Nguyen Duy Quynh Tram (2003) and Bounhong et al (2003) (89 and 84% for DM and 74 and 65%, respectively, for nitrogen) are less relevant as intakes in both these studies were low, which would have the effect of increasing the digestibility coefficients.

Digestibility coefficients on the WS diet (89 and 82% for DM and N) were similar to those (89 and 77%) reported by Prak Kea et al (2003) for pigs fed fresh water spinach (35% of the diet DM) as the only supplement to broken rice.

The superior nutritive value of the diets based on water spinach is shown by the nitrogen retention which was 40% higher on the WS diet compared with the FC diet. There appeared to be some synergism between the cassava leaves and the water spinach as the N retention on the WSFC diet (9.96 g/day) was almost as high as on the WS diet (10.3 g/day). from an experiment in progress (Chhay Ty 2005, unpublished data) Preliminary results from a pig growth experiment with the same diets indicate that the mixture of cassava leaves and water spinach may even be superior to the water spinach alone, thus providing support for the concept that mixtures of leaves may have complementary action in providing the required nutrients.

Conclusions

It is concluded that:

- * Fresh cassava leaves can be fed at 41% of the diet DM with no apparent signs of toxicity.
- * Fresh water spinach was more palatable than the cassava leaves as reflected in higher total DM intake and the proportion of the diet (47%) provided by the leaves.
- * Digestibility of dry matter, organic matter, N and crude fiber were higher in the diets with water spinach than those with cassava.
- * There are indication of complementarity between the two sources of leaves as indicated by the high N retention for the mixture being comparable with that for water spinach alone and superior to that for cassava alone.

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Yes