Water spinach and fresh cassava leaves

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Effect of different ratios of water spinach and fresh cassava leaves on growth of pigs fed basal diets of broken rice or mixture of rice bran and cassava root meal in Cambodia

On-farm trials to study the effect of (i) different levels of substitution of wilted cassava leaves by water spinach; and (ii) a basal diet of broken rice or a mixture (50:50) of rice bran and cassava root meal (with the permission of Livestock Research for Rural Development).

Twenty four crossbred (Local*Landrace or Local*Duroc) castrated male pigs weighing from 16.0 to 18.4 kg were used in a 2*3 factorial arrangement to study the effect of (i) different levels of substitution of wilted cassava leaves by water spinach; and (ii) a basal diet of broken rice or a mixture (50:50) of rice bran and cassava root meal. The feeding trial lasted for 120 days from 8 August to 6 December 2005. Higher intakes of water spinach and cassava leaves, and of total DM, were observed when the basal diet was broken rice rather than rice bran mixed with cassava root meal. Increasing the replacement of cassava leaves by water spinach from 10 to 30% resulted in increases in intake of the energy component, in the total quantity of foliage, and of total DM. Growth rates tended to be higher on the broken rice diet than on rice bran and cassava root meal; while the 30% level of water spinach was superior to the 10% level. The overall trend of live weight gain as a function of level of water spinach was curvilinear and positive, indicating a synergistic effect on performance from mixing increasing amounts of water spinach with fresh cassava leaves.

Key words:
cassava leaves, growth, broken rice, cassava root meal, rice bran, pigs, protein, water spinach

Introduction

In a previous experiment (Chhay Ty and Preston 2005) with growing pigs fed a basal diet of broken rice, we showed that a supplement of a 50:50 mixture (DM basis) of water spinach (*Ipomoea aquatica*) and fresh cassava leaves (*Manihot esculenta*) supported growth rates that were 32% higher than the average of the growth rates on the two sources of foliages fed separately. In the present experiment the hypothesis to be tested was that lower proportions of water spinach would also have a synergistic effect on growth of pigs fed low protein basal diets.

Materials and methods

Location

The experiment was carried out from 8 August to 6 December 2005 in 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 .

Experimental animals, treatments and design

Twenty four crossbred (Local*Landrace or Local*Duroc) castrated male pigs with initial body weight from 16 to 18.4 kg were allocated to six treatments with 4 replicates per treatment in a 2*3 factorial arrangement. The factors were:

Energy

- Broken rice
- Cassava root meal mixed with rice bran

Protein supplement

Proportions of water spinach (WS) and fresh cassava leaves (FCL) in ratios (DM basis) of:
- WS 10% and FCL 90%
- WS 20% and FCL 80%
- WS 30% and FCL 70%

The pigs were allocated into 2 blocks according to live weight (means for each block were 14.6 and 20.3 kg). The nutritional treatments were applied at random within each block. The pigs were housed in individual pens with concrete floors and provided with feeders and drinking nipples. The pigs were vaccinated against Salmonella disease and were adapted to the feeds and the housing for 7 days before starting the experiment.

Feeding and management

Broken rice and rice bran are by-products of Cambodian rice mills and were available in the local area. Cassava root meal was purchased from a store in the city. Fresh cassava leaves were harvested every day from plots in CelAgrid (Photo 1) or they were purchased from a farmer near the center. The water spinach was purchased from traders who harvested it from lagoons receiving waste water from Phnom Penh city.

The leaves plus stems of the water spinach and the leaves of cassava (after removing stems and petioles) were chopped into small pieces and wilted over-night and then mixed with the other ingredients of the diet (Tables 1 and 2) before being offered in 3 meals at 8.00, 12.00 and 17.00h. The amounts of feeds offered were based on the allowance of 40 g DM per 1 kg live weight of the pigs, with the broken rice (or mixture of rice bran and cassava root meal) supplying 50% and the

mixtures of leaves providing the remainder.

Table 1:

Chemical characteristics of the ingredients of the diets

	DM **%**	**N*6.25** **% in DM**	**HCN** **mg/kg DM**
Cassava leaves	29.8	27.1	351
Water spinach	8.47	31.1	-
Broken rice	86.5	7.90	-
Rice bran	89.4	10.8	-
Cassava root meal	97.2	3.12	-

Table 2

: Composition (DM basis) and analysis of diets

	WS10BR	**WS20BR**	**WS30BR**	**WS10RBCRM**	**WS20RBCRM**	**WS30RBCRM**
Ingredients, % DM basis						
Water spinach	10.0	20.0	30.0	10.0	20.0	30.0
Cassava leaves	40.0	30.0	20.0	41.0	30.0	20.0
Broken rice	49.5	49.5	49.5			
Cassava root meal	-	-	-	24.0	25.0	25.0
Rice bran	-	-	-	24.5	24.5	24.5
Salt	0.5	0.5	0.5	0.5	0.5	0.5
Total	100	100	100	100	100	100
Analysis						
Dry matter, %	55.6	53.5	51.3	58.3	55.9	54..7

N*6.25, % in DM	17.8	18.3	18.6	17.6	17.8	18.2
HCN, mg/kg DM	14.0	10.5	3.51	14.4	10.5	3.51

Data collection and analyses

The pigs were weighed every 10 days during the trial which lasted 120 days. Individual feeds offered and residues were recorded daily. Samples of feeds and residues were analysed for DM, N and HCN. The DM content was determined using the micro-wave method of Undersander et al (1993). N and HCN were determined following procedures of AOAC (1990).

Statistical analysis

Data for weight gain, DM feed intake, crude protein intake, HCN intake and feed conversion rate were analysed using the general linear model (GLM) option of the ANOVA software of Minitab (2000). The sources of variation were blocks, level of water spinach, energy, interaction energy*level of water spinach and error.

Results and discussion

Feed intake

Higher intakes of water spinach and cassava leaves were observed when the basal diet was broken rice rather than rice bran mixed with cassava root meal (Table 3), with total DM intakes being higher for the latter when expressed on a live weight basis. Replacing cassava leaves with water spinach resulted in increases in intake of the energy component, and in the total quantity of foliage, but a decrease in the intake of cassava leaves (Figures 1 and 2).

Table 3
: Mean values (main effects) for feed intake of pigs fed broken rice or rice bran + cassava root meal supplemented with mixtures of fresh cassava leaves and fresh water spinach

	Energy	**Level of water spinach**	**Interaction**			

	BR	RBCRM	SEM	Prob.	WS10	WS20	WS30	SEM	Prob.	Prob.
Intake of feed ingredients, g DM/day										
RBCRM		611			279	284	352	6.28		
BR	586				275	277	327	4.37		
CL	310a	288b	4.60	0.010	354a	279b	264c	5.64		
WS	264a	242b	3.69	0.001	127	248	384	4.53		
Foliage DM	575	530			481	528	647			
Total DM	1160	1140	11	0.200	1036a	1089b	1326c	13.9	0.001	0.07
g/kg LW	35.2a	37.3b	0.190	0.001	34.2a	37.0b	37.6b	0.23	0.001	0.033
N*6.25 , g/d	34.1a	31.3b	0.34	0.001	28.0a	30.8b	39.3c	0.42	0.001	NS
HCN										
mg/d	124a	115b	1.45	0.001	147a	116b	96.6c	1.78	0.001	0.001
mg/kg LW	3.97	3.99	0.04	0.72	4.99a	4.10b	2.86c	0.05	0.001	0.02

ab Means within main effects within rows without common letter are different at P<0.05

On a live weight basis the HCN levels consumed were 4.99, 4.1 and 2.86 mg/kg LW, for the water spinach 10, 20 and 30% levels, respectively. These were lower than in the earlier study (Chhayty et al 2005) and in the range reported as potentially toxic: 1.4 by Getter and Baine (1938), 2.1 to 2.3 by Johnson and Ramond (1965), 3.5 by Tewe (1992) and 4.4% of LW by Butler (1973).

Growth and feed conversion

Growth rates tended to be higher on the broken rice diet than on rice bran and cassava root meal during the initial, final and overall trial period. For the periods 40 to 80, 80 to 120 and overall, the 30% level of water spinach was superior to the 10% level.

Table 4
: Mean values for initial and final live weights, and growth rates, of pigs fed broken rice or a mixture of rice bran and cassava root meal supplemented with different levels of water spinach replacing fresh cassava leaves

	Energy				**Water spinach, % replacement of cassava leaves**				
Days	**BR**	**RBCRM**	**SEM**	**Prob.**	**WS10**	**WS20**	**WS30**	**SEM**	**Prob.**
Growth rate, g/day									
0-40	273	225	16.9	0.07	234	229	284	20.8	0.15
40-80	327	293	19.3	0.24	249a	321ab	360b	23.8	0.013
80-120	427	341	18.5	0.06	3394a	355a	456b	22.6	0.004
0-120	337	290	17.5	0.079	267a	306ab	367b	21.4	0.015
Live weight, kg									
Initial	17.7	17.3	0.69	0.67	18.0	16.0	18.4	0.84	0.13
Final#	58.2	50.2	2.3	0.025	49.7a	52.6a	60.4b	2.9	0.044

ab Means within rows within main effects, without common letter are different at P<0.05

 # Adjusted for differences in initial weight

Figure 2:

Growth curves of pigs fed basal diet of broken rice

supplemented with different levels of water spinach (WS)

replacing cassava leaves

Figure 3:

Growth curves of pigs fed basal diet of rice bran and

cassava root meal supplemented with different levels of water

spinach (WS) replacing cassava leaves

Figure 4:

Growth rates of the pigs during successive 40 day periods

and overall, according to supplementary level of water spinach with

basal diet of broken rice

Figure 5

: Growth rates of the pigs during successive 40 day periods

and overall, according to supplementary level of water spinach with

basal diet of rice bran and cassava root mea

The overall trend of live weight gain as a function of level of water spinach was curvilinear and positive (Figures 6 and 7), indicating that the rate of increase in live weight gain by replacing cassava leaves with water spinach was more marked the higher the level of water spinach in the diet. The growth curves in Figures 2 and 3 indicate a similar trend.

Figure 6:

Relationship between growth rate and replacement

of cassava leaves by water spinach on broken rice diet

Figure 7:

Relationship between growth rate and replacement

of cassava leaves by water spinach on diet of rice bran and

cassava root meal

Feed conversion was better on the basal diet of broken rice than on the mixture of rice bran and cassava root meal and tended to improve (P=0.12 for the overall trial period) with increasing levels of water spinach (Table 5).

Table 5
: Mean values for DM feed conversion of pigs fed broken rice or a mixture of rice bran and cassava root meal supplemented with different levels of water spinach replacing fresh cassava leaves

	Energy				**Level of water spinach**				
Days	**BR**	**RBCRM**	**SEM**	**Prob.**	**WS10**	**WS20**	**WS30**	**SEM**	**Prob.**
0-120	3.44	4.06	0.07	0.001	3.91	3.70	3.65	0.08	0.12

ab Means within main effects within rows without common letter are different at P<0.05

Conclusions

- The synergistic effect on growth rate of pigs of replacing cassava leaves with water spinach, as the main protein source, was confirmed in that the relative response to substituting cassava leaves with water spinach increased as the degree of replacement was increased.
- There were no indications of HCN toxicity on any of the diets

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