The nutritive value of ensiled cassava leaves for young Mong Cai pigs fed high levels of protein

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Abstract

Eight Mong Cai castrate male pigs of mean initial weight 12.3 kg were fed diets containing sugar palm (Borassus flabellifer) syrup and dry fish substituted or not with ensiled cassava leaves (0 and 50% of the daily ration in dry basis) according to a change over design. The silage was made from sun-dried, wilted, chopped leaves and petioles in a single batch of cassava foliage harvested after 8 weeks of regrowth. The pH was 4.39, DM 41.2%, NDF 66.7%, N 2.87% and cyanide 120 mg/kg in dry basis. Mean environmental temperature was 34.5°C at midday (12:00) during the trial in May 2001.

The pattern of feed intake was characterized by a very fast intake of the syrup and a slow ingestion of solid materials. There were no silage refusals. Voluntary feed intake was 36.6 g DM/kg body weight per day. The animals were in a positive body weight balance when they were fed the ensiled cassava leaf-based diet and averaged 140 g body weight gain during the trial.
Nutrient digestibility of the silage as predicted by difference (n = 8) was DM 77.7%, organic matter 79.8%, NDF 82.5% and N 74.2%. There appeared to be a positive response in N retention due to incorporation of cassava leaf silage in the diet, either related to N intake (improvement of 10.6%) or to N digested (improvement of 19.2%; P<0.10). It appears that young Mong Cai pigs have a high capacity for digestion of cell wall materials, further supported by lower faecal pH values (P<0.05) and DM concentration (P<0.01) in the diet containing cassava leaf silage (6.74 and 29.3%) as compared to the basal diet (7.26 and 39.1%).

It is concluded that total N digestibility by pigs of ensiled cassava leaves can be high when the dietary protein supply is high and rich in sulphur amino acids.

*Key words: Pigs, ensiled cassava leaves, digestibility*

**Introduction**

The use of ensiled cassava leaves for pigs has been a subject of several investigations concerning ensiling technology (Bui Van Chinh 1990; Bui Van Chinh et al 1992; Chhay Ty et al 2001; Bui VanChinh and Le Viet Ly 2001), animal performance traits (Du Thanh Hang 1998; Nguyen Van Lai et al 2000; Bui Van Chinh and Le Viet Ly 2001) and the nutritive value of the material (Du Thanh Hang et al 1997; Nguyen Van Lai and Rodriguez 1998; Du Thanh Hang 2000). The experiments related to the observation of the ensiling process have been mainly directed to reducing the cyanide content. Furthermore, the levels of inclusion of ensiled cassava leaves have been relatively low and/or the protein formulation of the diet has been made with vegetable proteins. In fact, since the early work of Eggum (1970), it is well known that cassava leaves are very rich in lysine, but the sulphur amino acid content of the material is rather low. This point has received little attention, in spite of the fact that methionine is involved in the detoxification process in the animal (for review, see Tewe 1992).

In Cambodia there exist many possibilities for the use of dried fresh water fish for feeding monogastric species since water resources are abundant throughout the country. Fish protein is relatively rich in sulphur amino acids, thus it was of interest to consider the use of dried fresh water fish in diets for pigs fed high levels of ensiled cassava leaves.

The aim of the study reported in this present publication was to report some data concerning N balance in pigs fed diets high in protein, which was provided by dried fresh water fish and ensiled cassava leaves.
Materials and Methods

Eight Mong Cai, castrate male pigs of 12.3 kg mean initial live weight were fed diets containing sugar palm (*Borassus flabellifer*) syrup and dry fish (Table 1), substituted or not by ensiled cassava leaves (0 and 50% of the daily ration in dry basis) according to a two-period balanced changeover design (Gill and Magee 1976; Gill 1978). The silage was made by adding sugar palm syrup diluted with water 1:1 (fresh basis) to wilted (24 hours in the sun), chopped leaves and petioles harvested from a single batch of cassava foliage after 8 weeks re-growth. The level of addition was 50 g diluted syrup to 1 kg of wilted cassava leaves. The material ensiled had pH 4.39, DM 41.2%, NDF 66.7%, N 2.87% and cyanide 120 mg/kg in dry basis respectively.

Table 1. Characteristics of the basal diet and the experimental diet (ESL) with 50% of cassava leaf silage (percentage in dry basis)

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Basal</th>
<th>ESL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar palm syrup</td>
<td>53.0</td>
<td>26.5</td>
</tr>
<tr>
<td>Dry fish</td>
<td>44.4</td>
<td>22.2</td>
</tr>
<tr>
<td>Ensiled cassava leaves</td>
<td>-</td>
<td>50.0</td>
</tr>
<tr>
<td>Salt</td>
<td>0.6</td>
<td>0.3</td>
</tr>
<tr>
<td>Vitamins and minerals$^a$</td>
<td>2.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Analysis

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Basal</th>
<th>ESL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter</td>
<td>51.4</td>
<td>46.4</td>
</tr>
<tr>
<td>Ash</td>
<td>16.7</td>
<td>12.9</td>
</tr>
<tr>
<td>Organic matter</td>
<td>83.3</td>
<td>87.1</td>
</tr>
<tr>
<td>NDF</td>
<td>-</td>
<td>33.3</td>
</tr>
<tr>
<td>N</td>
<td>3.25</td>
<td>2.80</td>
</tr>
</tbody>
</table>

$^a$ According to NRC (1998) requirements for pigs

Details of the animals, housing and the experimental daily routine during the trial have been described elsewhere (Ly and Samkol 2001). The diets were given at a rate of 35 g DM/kg body weight per day at approximately 07:30 h each morning and refusals taken at 07:00 h the following day.
The ration was offered as a mash, by mixing diluted sugar palm syrup (1:1: by weight with water) with the other ingredients. Water was available ad libitum through drinking nipples. A preliminary adjustment period of five days was followed by another five days of collection. Other details related to faeces and urine sampling were described by Ly et al (2001a).

Chemical analysis of the diets and faeces was undertaken following the methods of Goering and Van Soest (1970) and Van Soest et al (1991) for NDF and AOAC (1990) for ash and N. The DM content was determined using the microwave method of Undersander et al (1993). Fresh faeces were analyzed for pH according to a procedure described by Ly et al (2001a). Ground samples of ensiled cassava leaves were incubated either in natura or after sun-drying, using the in vitro pepsin/pancreatin procedure according to Dierick et al (1985). The samples of ensiled cassava leaves were from four different days selected at random after opening the silage. Ground, dried samples of fresh water fish and casein (reagent quality) were incubated similarly. The analytical procedures applied to the residues after incubation were the same utilized in the in vivo experiment.

Nutrient digestibility and N balance coefficients were estimated by the conventional method and thereafter the nutritive value of ensiled cassava leaves meal was calculated by difference (Crampton and Harris 1969).

The data were subjected to analysis of variance to test the effect of dietary ensiled cassava leaves using standard procedures described elsewhere (Steel and Torrie 1980). Data were processed using the software package of MINITAB (Ryan et al 1985).

Results and Discussion

The mean environmental temperature was 34.5°C at midday (12:00) during the trial in May 2001. Practically, there were no feed refusals throughout the experiment, in contrast with previous results from pigs fed ensiled cassava foliage (Ly et al 2001b). Voluntary feed intake was 36.6 g DM/kg body weight per day and accounted for 99.7 ± 0.4 % of the offer, which was very voluminous. The high intake could be a consequence of using a high quality silage. It is known that there are several factors influencing ensiling of foliage (Wilkinson 1983a,b). Following the recommendations of Wilkinson (1983b), which emphasize ways of achieving a carefully controlled anaerobiosis, the resultant good quality of the silage could explain these results. The pattern of feed intake was characterized by a very fast intake of the syrup and a slow ingestion of
solid materials. On the other hand, all pigs were in positive weight balance and there was no symptom of animal discomfort due to the consumption of high proportions of ensiled cassava leaves in the diet. During the time they were fed the ensiled cassava leaves-based diet the average body weight gain was 140 g/day.

According to the design utilized, an analysis of variance was conducted to determine the effect of period on the measurements studied (Gill 1978). There was no residual residual effect of treatment (P<0.05).

Faecal DM concentration and pH decreased in pigs fed ensiled cassava leaves as compared with those fed the basal diet which was devoid of any vegetable fibre. These findings reflect the increase in microbial activity in the caecum and colon of the animals fed the cassava leaf silage (Jorgensen et al 1996). These results are in accordance with other data reported for pigs fed cassava leaves (Bui Nhu Phuc Bui et al 1996), and can be interpreted as the consequence of using high levels of fibrous materials in the diet of the animals (Fernandez and Jorgensen 1986), which in turn leads to an increase in organic matter disappearance in the large intestine. In this connection, the digestibility of cell walls was very high (82%), which may be related to the particular characteristics of the genotype of pigs used in the trial.

There was a trend for DM and N digestibility to be lower (P> 0.10) and organic matter digestibility was significantly lower (P<0.01) in the pigs fed the silage. Other researchers have reported a reduction in digestibility indices as a linear consequence of increasing the level of ensiled cassava leaves in the diet (Bui Hong Ngu Phuc et al 1996; Du Thanh Hang 2000). In contrast to the digestibility coefficients, the N retention was high in pigs fed the diet with ensiled cassava leaves, and a trend was observed (P<0.06) for N retention, expressed as percentage of digestion, to be improved (the observed increase was 19%).

| Table 2. Nutrient digestibility and N balance in pigs fed a basal diet of sugar palm juice and dried fish with (ECL) and without ensiled cassava leaves (Basal) |
|-----------------|--------|--------|--------|
| Basal ECL SEM   |
| **Faecal characteristics** |        |        |        |
| Faecal DM, %    | 39.1   | 29.4   | 2.28** |
| Faecal pH       | 7.26   | 6.74   | 0.25*  |
| **Digestibility, %** |        |        |        |
| DM              | 81.5   | 79.6   | 1.7    |
| Organic matter  | 90.0   | 85.1   | 1.3**  |
The net improvement in N balance of the pigs fed the high levels of ensiled cassava leaves is in marked contrast with results reported in Vietnam by Bui Hong Ngoc Phuc et al (1996) and Du Thanh Hang (2000), where N retention decreased with increasing level of inclusion of cassava leaf silage in the diet. The explanation for such conflicting results is not readily apparent. One reason could be found in the fact that the cassava leaves used in the Vietnamese trials were obtained as a by-product after harvesting the roots, whereas in our experiment the leaves were taken from cassava grown as a semi-perennial forage with regular harvests of the foliage every 2 to 3 months (Preston et al 2000). It is suggested that there may be differences between the two type of foliages from the point of view of leaf age, perhaps reflected in different degrees of lignification and availability of N.

Since the early report from Eggum (1970), it is well known that, although cassava leaves contain a relatively high proportion of lysine in the protein, the contrary is true from the point of view of methionine content. This evidence must be taken into account when high levels of cassava leaves are used in the diet. Therefore, to some extent, the use of dried fresh water fish as a complementary protein source, rich in sulphur amino acids, could explain at least partially the good results from the present study.

The nutritive value of the silage appeared to be high (Table 3) as determined by the difference method. This was a direct consequence of the high values found for the complete diet, of which the cassava leaf silage accounted for 50% of the dry matter. There was some variability among the pigs for the digestion coefficients, being highest for nitrogen where the coefficient of variation was 17%.

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<table>
<thead>
<tr>
<th>Table 3. Composition (DM basis) and calculated digestibility coefficients of the ensiled cassava leaf silage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composition (%)</td>
</tr>
<tr>
<td>Dry matter</td>
</tr>
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</table>

\[ P<0.10; \; * P<0.05; \; ** P<0.01 \]
Organic matter 89.1 79.8 ± 6.65
NDF 66.6 82.6 ± 5.64
N 2.87 74.2 ± 12.36

* Mean and SD from eight animals

In vitro pepsin/pancreatin N digestibility of the ensiled cassava leaves was high (Table 4), both in fresh samples and after sun-drying. There were no significant differences between the two preparations of the silages in N, organic matter and DM digestibility. However, the dried fish used in the in vivo trial was significantly higher (P<0.001) in all the measurements studied. It is known that in vitro digestibility of dried fish can be as high as that of fish meal (Ly et al 2001a; Ly and Samkol 2001).

Table 4. In vitro pepsin/pancreatin digestibility of ensiled cassava leaves

<table>
<thead>
<tr>
<th></th>
<th>DM</th>
<th>Organic matter</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ensiled cassava leaves</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In natura</td>
<td>43.4a</td>
<td>44.6a</td>
<td>63.2a</td>
</tr>
<tr>
<td>Sun-dried</td>
<td>41.7a</td>
<td>43.5c</td>
<td>62.0a</td>
</tr>
<tr>
<td>Dry fish</td>
<td>66.9b</td>
<td>78.9b</td>
<td>78.5b</td>
</tr>
<tr>
<td>SEM</td>
<td>3.0***</td>
<td>3.2***</td>
<td>2.7***</td>
</tr>
</tbody>
</table>

* Samples from four different days of silage utilization
** In vitro digestibility of casein was 99.5 ± 0.5%
*** P<0.001

ab Means within the same column with different superscripts differ (P<0.05)

Conclusions

It is concluded that total N digestibility by pigs of ensiled cassava leaves can be high when the dietary protein supply is high and rich in sulphur amino acids.

Acknowledgements

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References


Du Thanh Hang 2000 Digestibility and nitrogen retention in fattening pigs fed different levels of ensiled cassava leaves as a protein source and ensiled cassava root as energy source. In: Making better use of local feed resources (T R Preston and R B Ogle, editors). University of Agriculture and Forestry, Thu Duc, Ho chi minh City pp 8


Ly J, Chhay Ty, Chiev Phiny, Preston T R and Rodriguez L 2001b Algunos aspectos del valor nutritivo del ensilado de forraje de yuca dado a cerdos Mong Cai alimentados con dietas de poca proteina. Revista Computadorizada de Produccion Porcina 8(suplemento 1):in press


Nguyen Van Lai and Rodriguez Lylian 1998 Digestion and N metabolism in Mong Cai and Large White pigs having free access to sugar cane juice or ensiled cassava root supplemented with duckweed or ensiled cassava leaves. Livestock Research for Rural Development 10(2): http://www.cipav.org.co/lrrd/lrrd10/2/lat1021.htm


