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Protein-enriched cassava root meal improves the growth performance of Moo Lat pigs fed ensiled taro (*Colocacia esculenta*) foliage and banana stem

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Abstract

Fresh cassava roots were supplemented with urea and di-ammonium phosphate and fermented anaerobically with yeast to increase the content of protein. In a growth trial with 12 Moo Lat pigs, the protein enriched cassava root (PECR) partially replaced ensiled taro foliage in a basal diet with ensiled banana stem as energy source, and with addition of 1% (in DM) of biochar.

Supplementation with protein enriched cassava root increased DM intake and growth rate. There were indications of positive effects of the biochar on growth rate and feed conversion when it was added to the control diet comprising only ensiled banana and ensiled taro foliage.

Key words: *biochar, fermentation, indigenous pigs, yeast*

Introduction

Livestock are very important for the farmers in the rural areas of Lao PDR, especially small animals such as pigs, which account for more than 50% of total family income in the remote areas of Northern Lao PDR (Phengsavanh and Stür 2006). The number of pigs kept by a household varies between 1.4 and 3.7 animals, depending on the region (Knips 2004). The native breeds account for more than 90% of the pig population and include: Moo Chid, Moo Laat, Moo Daeng and Moo Nonghaet. Indigenous pigs grow slowly and take a long time to reach slaughter weight but are well adapted to a free-ranging system and can survive in a hot climate on low quality feed, and with a high resistance to diseases (Vongthilath and Blacksell 1999). Phengsavanh et al (2010) reported that another reason for raising indigenous pigs was a high local market demand, their better adaptation to the local environment and management conditions, and tastier meat. Pigs can be sold when cash is needed for buying rice and other foods, for paying school fees, or if a household member needs medical attention (Phengsavanh and Stür 2006).

Taro (*Colocacia esculenta*) grows widely in Lao PDR and is used as a vegetable for human consumption and as feed for livestock. However, the plant contains oxalic acid present as calcium salts which form small crystals in all parts of this plant, and when consumed cause irritation in the mouth and throat epithelium (Miller 1929). Normally, the taro leaves are cooked with rice or rice bran and cassava roots, in order to reduce the concentration of calcium oxalate before feeding them to pigs. Recent research in Vietnam and Cambodia showed that the oxalate problem could be avoided by ensiling the leaves alone or combined with the stems (Hang and Preston 2010; Chhay Ty et al 2007; Giang et al 2011; Manivanh et al 2011).

Banana stems are often used by Lao farmers as animal feed especially for pigs, after chopping and mixing them with rice bran. Banana stem is low in protein and has a high fibercontent. However, when ensiled together with taro foliage (leaves plus stems) it was comparable to rice bran as the basal diet for reproduction in local (Mong Cai) sows in Vietnam (Duyet et al 2013) and for growth of crossbred pigs in Cambodia (Chhay et al 2014).

Cassava (yuca or manioc) is a starchy tuber in the spurge family (Euphorbiaceae) of plants from the South-American region. Its underground tuber is a popular edible root since centuries for indigenous people of many parts of Africa, Asia and South America. Together with other tropical roots and starch-rich foods like yam, taroand plantains it is an indispensable part of the carbohydrate component of the diet for millions of inhabitants living in these regions http://www.nutrition-and-you.com/cassava.html

The root is composed almost entirely of starch and contains very little protein (less than 3% in the dry matter; http://www.feedipedia.org/), thus it is necessary to supplement it with protein-rich feeds such as fish and soybean meals in order to make a balanced diet for pigs. These protein meals are expensive in Lao PDR as they are mostly imported.

One way to inprove the protein content of carbohydrate-rich feeds is by solid-state fermentation with fungi and yeasts (Araujo et al 2008; Hong and Ca 2013). The fermentation of cassava meal with *S. cerevisiae* enhanced the protein level from 4.4% to 10.9% in DM and decreased the cyanide content (Oboh and Kindahunsi 2005).

The aim of the experiment reported in this paper was to test the method for protein enrichment of cassava root meal and

evaluate the enriched product as a partial replacement for taro silage (leaves and stems) in a fattening diet for local pigs with ensiled banana stem as the source of energy. The incorporation of 1% biochar in the diet was also evaluated in view of positive responses reported on the use of this additive in the diets of other live stock (Leng et al 2012).

Materials and methods

Location and climate of the study area

The experiment was carried out from April to September 2014 at the Faculty of Agriculture and Forest Resource in Souphanouvong University. The site is located 7 km from Luang Prabang City, Lao PDR. The mean daily temperature in this area at the time of the experiment was 27 ^{o}C (range 22-32 ^{o} C).

Experimental design

The experiment was arranged as a 2*2 factorial in a completely randomized block design (CRBD) with 4 treatments and 3 replications. The two factors were:

Protein enriched cassava root (PECR)
PECR or No-PECR
Biochar (Bio)
Bio or No-Bio

Individual treatments (DM basis) were:

- No-PECR; No-Bio: Taro silage (TS) 70% + Ensiled banana stem (EBS) 30%
- No-PECR; Bio: TS69% + EBS 30% + 1% Biochar
- PECR: TS45% + EBS 25% + PECR 30%
- PECRBio: TS44% + EBS 25% + PECR 30% +1% Biochar

Protein enrichment of cassava root

The cassava roots were brought from Nan District in Luang Prabang Province. They were chopped into small pieces (1-2cm) and steamed for 25 minutes and then cooled to ambient temperature (30ºC) before mixing with yeast, diammonium phosphate (DAP) and urea (Cassava root meal 100 kg + DAP 0.2kg + yeast 0.5kg + urea 1.14kg [all on fresh basis]). The mixed substrate was spread in a thin layer (2-3cm deep) on a tray and allowed to ferment aerobically. Samples for analysis and for feeding were taken after 6 days of fermentation.

Animals and management

Twelve local (Moo Lat) pigs with a mean body weight of 15kg were bought from a pig farm in Xayabouly Province. They were vaccinated against swine fever and were treated against round worms with Ivermectin (1ml/20kg LW), before starting the experiment.

The pigs were housed in individual pens (width 1m and length 1.2m) made from local materials (Photos 1 and 2). The pigs had free access to water through nipple drinkers. The diet ingredients were mixed together and given two times per day at 6:30 am and 5:30 pm, the amount being based on an offer level of 40g DM/kg live weight.

Photo 1. Housing made from local materials

Photo 2. Moo Lat pigs in individual pens

Data collection

The pigs were weighed in the morning before feeding, at the beginning of the trial and every 15 days. Live weight gain was determined from the linear regression of live weight on days in the experiment. Samples of feed offered and refused were collected daily, weighed and sub-samples stored in the refrigerator at 4°C before being analysed for DM, N and ash, according to AOAC (1990) methods.

Statistical analysis

Data of feed intake, live weight and feed conversion were analysed with the General Linear Model option of the ANOVA program in the MINITAB software (2000). Sources of variation were: protein source, biochar, interaction protein

souyrce*biochar and error.

Results and discussion

Chemical composition

The concentrations of crude protein were similar for the ensiled taro and protein enriched cassava root (Table1).The level of crude protein in the ensiled banana stems was very low.

Table 1. The chemical composition of the feed ingredients (% in DM, except DM which is on fresh basis)

	DM	N*6.25	OM
Taro silage	27.8	16.4	78.6
Ensiled banana stem	5.9	4.9	96.9
Protein enriched cassava root (PECR)	36.4	16.5	98.4

Feed intake, growth rate and feed conversion

DM intake was increased by 17% when protein-enriched cassava root replaced part of the taro silage (Table 2; Figure 1).

Table 2. Mean values for DM intake (g/day) by pigs fed taro silage (TS) and ensiled banana stem (BS) supplemented with protein enriched cassava root (PECR) or biochar (Bio) or not supplemented

	No-PECR	PECR	*p*	No-Bio	Bio	*p*	SEM
TS	590	392		491	491		
BS	163	157	0.006	160	160	0.86	1.73
PECR	0	315		162	153	0.001	2.07
Biochar	3.81	3.23		0	7.04		
Total	757	866	<0.001	812	810	0.87	8.72
Per kg LW	37.4	43.7	<0.001	41.1	40		0.16

Figure 1. Effect of supplementation with protein enriched cassava root and biochar, separately or together, on the DM intake of pigs fed a basal diet of taro silage and ensiled banana stem

Figure 2. Effect on DM intake (g/kg LW) of protein enriched cassava root (PECR) replacing part of the taro silage in growing pigs fed taro silage and ensiled banana stem as basal diet

The daily live weight gain was improved by replacing one third of the taro silage with enriched cassava root (Table 3; Figure 3). There was a suggestion that biochar increased the live weight gain on the diet that contained only ensiled banana stem and taro foliage but had no effect when the protein-enriched cassava root replaced part of the taro silage (Figure 4).

Table 3. Feed consumption and live weight changes of growing pigs during the experiment

	No-PECR	PECR	*p*	No-Bio	Bio	*p*	SEM
Live weight, kg							
Initial	16.9	15.5	0.50	15.9	16.5	0.75	1.50
Final	25.1	26.4	0.64	25	26.4	0.60	1.78
Daily gain, g/day	115	152	0.022	127	140	0.24	8.10
DM intake, g/day	757	866	<0.001	810	812	0.87	8.72
DM conversion	6.7	5.7	0.21	6.5	5.8	0.34	0.49

Figure 3. Effect of protein enriched cassava root replacing taro silage on live weight gain of Moo Latpigs

Figure 4. Effect of supplementation with protein enriched cassava root and biochar, separately or together, on the growth rate of pigs fed a basal diet of taro silage and ensiled banana stem

The positive effect of protein-enriched cassava root on live weight gain is similar to the growth response in pigs reported by Phuong et al (2003)for cassava pulp enriched from 3 to 5.5% true protein using the fungus *Aspergillus niger*. Huu and Khammeng (2014) replaced maize with fermented cassava pulp containing 13% crude protein (DM basis) and reported similar digestibility and N retention as in the control diet. Part of the improvement in growth rate from feeding the protein-enriched cassava root could be the result of its superior biological value compared with the protein in the taro foliage. The other possibility could be the increased provision of vitamins of the B-complex from the yeast in the fermented cassava

root.

Conclusions

- Supplementation with protein-enriched cassava root increased DM intake and growth rate and improved feed conversion in Moo Lat pigs fed a basal diet of ensiled banana stem and ensiled taro foliage.
- There were indications of positive effects of the biochar on growth rate when it was added to the control diet comprising only ensiled banana and ensiled taro foliage.

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