



## Inclusion of Ensiled Cassava KM94 Leaves in Diets for Growing Pigs in Vietnam Reduces Growth Rate but Increases Profitability

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**ABSTRACT :** This study was conducted to determine the effect of the inclusion of different levels of ensiled cassava leaves (variety KM94) in the diets on performance and carcass characteristics of growing pigs in Vietnam. A total of 40 crossbred pigs (Large White × Mong Cai, 20 males and 20 females) with an initial live weight of 23.5 kg (SD = 0.86) were randomly allocated to one of the four pens across 5 units. Four experimental diets were formulated for two growth periods, period 1 (60 days) for 20 to 50 kg and period 2 lasted 30 days, from 50 kg until slaughter. Four diets were formulated containing inclusion levels of ensiled cassava KM94 leaves diet of 0, 10, 15 and 20% in the DM. Diets were formulated based on previously determined ileal amino acid digestibility values of the KM94 products and were isonitrogenous and isocaloric on a metabolizable energy basis. Each pen of pigs was randomly assigned to one of the four dietary treatments. Dry matter intake and final weight tended to decrease with increasing levels of ensiled cassava KM94 leaves in the diet while there was a significant ( $p = 0.022$ ) decrease in average daily gain. Protein depositions of the F1 pigs tended ( $p = 0.093$ ) to decrease with increasing inclusion levels of ensiled cassava KM94 leaves. There was no significant difference in feed conversion ratio, carcass quality and fat gain between the groups of pigs. There were clear differences in feed costs among the experimental diets ( $p = 0.001$ ) with increasing levels of ensiled cassava KM 94 leaves in the diet reducing feed costs. It was concluded that, in diets for growing pig, inclusion of ensiled cassava leaves reduces growth rate of pigs in Vietnam but increases profitability as measured by feed costs. (**Key Words :** Cassava KM94 Leaves, Carcass Characteristics, Feed Conversion Ratio, Feed Costs, Growing Pigs, Protein Deposition)

### INTRODUCTION

In Vietnam, cassava production has rapidly changed from a food crop to an industrial crop. Each year more and more land area is used for cultivation of cassava, yielding more and more cassava roots and leaves. New high-yielding cassava varieties, such as KM94 and KM98-5 and KM140 have been distributed to various provinces in Vietnam over recent years. In 2007/2008, 560,000 ha were planted with cassava of which more than 350,000 ha with new varieties, mainly KM94 (GSO, 2008). At the time of root harvest, the yield of fresh foliage of a variety like KM94 is approximately 9 tons/ha and leaf yield approximately 5-7 tons/ha (Phuoc, 2004; Ly and Ngoan, 2007). Cassava

variety KM94 has been specifically developed for its high root yield and may provide farmers an increased return. The leaves of cassava variety KM94 have a level of crude protein which ranges between 25 to 34.7% in DM (Phuc et al., 2000; Kinh, 2003; Ly and Ngoan, 2007) and after suitable treatment to reduce the HCN content, it can be used as a protein source in animal feeds. Phuc et al. (2000) showed that cassava variety KM94 has a higher HCN content compared to other varieties. Ly and Ngoan (2007) found that the HCN content of fresh KM94 cassava leaves was 1,745 mg/kg DM which was decreased by 51% after 24 h of wilting (sun drying). The initial inclusion of rice bran or cassava root meal in cassava silage at levels of 5 or 10% produces a good quality silage that can be stored for at least five months (Ly and Ngoan, 2007). The HCN content of the ensiled KM94 cassava leaves decrease very quickly during the first 30 days of ensiling, and after 90 days of ensiling it is only 10 to 13% of the initial concentration (Ly and Ngoan, 2007). There have been no studies investigating the nutritive value of ensiled KM94 cassava leaves in the diet for pigs.

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The objective of the present study was to evaluate the efficacy of using different levels (from 0 to 20% ) of ensiled KM94 cassava leaves in diets on the performance and on carcass characteristics of growing pigs under farming condition in Central Vietnam.

## MATERIALS AND METHODS

### Preparation and preservation of silage of cassava KM94 leaves

This experiment was carried during the wet season in Vietnam. Fresh leaves of cassava KM 94 were collected at the time of root harvest and spread out on a concrete floor for wilting. The DM of fresh cassava (KM94) leaves was 25% and after wilting for 24 h increased to 34%. After wilting the leaves were separated from the stems and petioles, chopped into small pieces (2-3 cm), mixed with 0.5% of NaCl and 5% of rice bran of the wilted weight of the cassava KM94 leaves. The mixture was kept in nylon bags with a capacity of 30 kg, and kept airtight and stored for 2 months before use.

### Location

The experiment was carried out in five units in the Huong Van community, which is one of the main pig production areas of the Thua Thien Hue province in Vietnam. Each unit consists of 8 pigs. The protocol of the experiment was approved by the ethical committee of Hue University, Hue, Vietnam.

### Animals and experimental design and feeding

Forty (20 males and 20 females) crossbred (Large White×Mong Cai) pigs of with an average initial weight of 23.5 kg (SD = 0.86) and with similar age were randomly allocated within sex to five units. In each unit, 4 male and 4 female pigs were randomly allocated to four pens, with 2 pigs (1 male and 1 female) per pen. Within a unit, each pen (2×1 m (length×width)) was randomly allocated to one of the four dietary treatments. The trials used a completely randomized block design with four levels of ensiled cassava

(KM94) leaves in the diets and 5 replicates per treatment. The four experimental diets contained 0, 10, 15 and 20% of ensiled cassava KM94 on a dry matter basis (DM). The pigs had been vaccinated against Hog Cholera and Pasteurellosis and were de-wormed 2 weeks before starting the experiment.

Four diets were formulated for the two growing periods of the animals: weight range 20-50 kg, duration 60 days (period 1) and weight above 50 kg, duration 30 days (period 2). In period 1 pigs received a diet with ~14% CP in which 15.0-22.4% of the total CP originated from ensiled KM94 and in period 2 a diet with ~12% of CP in which 26-34% of the total CP came from the ensiled KM94 mixture. The experiment lasted 90 days with feed allowance for all treatments set at 4% of body weight. The diets were distributed equally into 3 meals per day (7 h; 11 h and 17 h). Refusals were collected the following morning before the first meal. Drinking water was provided *ad libitum*. The trial was designed as a complete randomized block with four levels of ensiled KM94 of 0, 10, 15 and 20% in DM of the diets. The treatments are called FM, 10 KM94, 15 KM94 and 20 KM94 diets.

The basal diet (fish meal diet (FM)) contained rice bran, yellow corn, ensiled cassava roots and sweet potato vines (Table 1). Metabolizable energy content in the diet was calculated according to formulas used for estimation of energy values in pig feeds in Vietnam as provided by the National Institute of Animal Husbandry (NIAH, 2001).

Four diets were composed and aimed to have (in DM) around 12.6 MJ of ME and 14% CP; 0.65% lysine and 0.25% methionine for period 1 and for period 2: 12.6 MJ ME and 12.1% CP; 0.55% lysine and 0.23% methionine. The source of protein in the experimental diets was fishmeal and ensiled cassava KM 94 leaves only and contained sufficient CP and apparent ileal digestible EAA to enable optimum performance.

### Chemical analyses

Samples of diet ingredients were dried at 60°C for 24 h and ground over a 1 mm screen before analysis. DM, CP,

**Table 1.** Ingredients and their determined chemical composition used to formulate the experimental diets

Ingredients	Rice bran	Maize meal	ECR <sup>1</sup>	Fish meal	SPV <sup>1</sup>	ECL <sup>1</sup> KM94
ME (MJ/kg DM)	12.1	14.9	12.4	13.2	9.4	10.3
Crude protein (% DM)	11.5	9.6	3.1	58.5	17.8	21.0
Crude fat (% DM)	15.6	2.7	4.0	ND	18.0	11.7
Lysine (g/kg DM)	4.9	3.1	1.1	33.3	7.1	9.2
Methionine (g/kg DM)	2.3	1.9	0.4	10.5	2.3	3.2
Hydrogencyanide (mg/kg DM)	ND	ND	55.0	ND	ND	195

<sup>1</sup> ECR = Ensiled cassava root; SPV = Sweet potato vines; ECL KM94 = Ensiled cassava KM94 leaves; ECR and ensiled cassava KM94 leaves analysis at 60 days after ensiling.

ND = Not determined.

crude fat (CF) were determined in the samples according to standard AOAC methods (AOAC, 1990). Amino acids were analysed according to Spackman et al. (1958) on an ion-exchange column using an HPLC. Samples were hydrolysed for 24 h at 110°C with 6 M HCl containing 2 g/L reagent grade phenol and 5,000 nmol norleucine (internal standard) in evacuated and sealed ignition tubes. Methionine were determined as methionine sulphone with separate samples were hydrolyzed for 24 h as described above following oxidation with performic acid overnight at 0°C (Moore, 1963). All samples were analyzed in triplicate except amino acid which were analysed in duplicate. All analyses except the amino acid analyses were done at the Hue University laboratories with amino acids determined by the National Institute of Animal Husbandry (NIAH) laboratories in Hanoi.

### Measurement

Feed consumption was determined by weighing the amounts feed given and corrected for any feed remaining the following morning. This correction was done by determining the DM of feed offered and feed refusals. The pigs were individually weighed at the start and at the end of each month and also at slaughter. Daily weight gain, daily

feed intake, feed conversion ratio and feed cost/kg live weight gain were estimated for each treatment. The costs were derived using the market price for each ingredient, amount used and growth of each pigs to calculate the price of 1 kg of feed as DM.

For the evaluation of carcass traits, 3 representative pigs (2 males and 1 female) from each treatment were slaughtered at the final body weight (70-75 kg). The pigs were starved for 24 h, weighed and then slaughtered at the slaughterhouse in Hue City. Carcass weights were measured according to Kauffman and Epley (2000). Hot carcass weights were measured immediately after slaughter. Carcass weights without blood, hair and internal organs were recorded and also the weight of the hot carcass without head. The carcass ratio was calculated as the ratio between carcass mass as a proportion of live body weight after the pigs have been starved for 24 h. The P<sub>2</sub> back fat thickness was measured on the partitioned carcass 10 cm from the midline behind the tenth rib using a ruler, and loin area was measured by trace paper (70 g/m<sup>2</sup>) at slaughter. Carcass length was measured from the first rib to the pubic bone. Lean percentage was calculated as the ratio of lean mass to hot carcass weight according to the equation published by Kauffman and Epley (2000):

**Table 2.** Ingredient content and chemical composition of the experimental diets for F1 (Large White×Mong Cai) pigs over two weight periods, 20-50 kg and 50 kg to slaughter

Ingredients <sup>3</sup>	Fish meal		10KM94 <sup>1</sup>		15KM94		20KM94	
	20-50	>50	20-50	>50	20-50	>50	20-50	>50
Rice bran (%)	32	38	32	36	30	35	30	28
Maize (%)	18	16	18	18	21	19	24	24
Ensiled cassava root (%)	30	30	30	30	26	27	20	25
Fish meal (%)	10	6	10	6	8	4	6	3
Sweet potato vines (%)	10	10	-	-	-	-	-	-
Ensiled cassava leaves (%)	-	-	10	10	15	15	20	20
Chemical composition (% DM)								
ME (MJ/kg)	12.6	12.5	12.6	12.6	12.6	12.6	12.6	12.6
ME from ECL (%)	0	0	8.1	8.2	12.3	12.4	16.4	16.4
Crude protein (%)	14.0	12.1	14.3	12.2	14.1	12.2	14.1	12.2
Crude protein from ECL (%)	0	0	15	17	22.4	26	30	34
Crude fat (%)	8.5	8.9	7.9	8.5	8.0	9.2	8.5	8.5
Lysine (g/kg)	6.5	5.7	6.6	5.6	6.5	5.3	6.3	5.3
Ileal dig. lys <sup>2</sup> (g/kg DM)	4.91	4.26	5.06	4.18	4.83	3.96	4.67	3.87
Methionine (g/kg)	2.5	2.3	2.6	2.3	2.5	2.2	2.5	2.2
Ileal dig. Met <sup>2</sup> (g/kg DM)	1.85	1.72	1.92	1.67	1.87	1.62	1.86	1.6
Hydrogencyanide (mg/kg)	16	16	36	36	44	44	50	52

<sup>1</sup> 10KM94, 15KM94 and 20KM94 contain 10, 15 and 20% ensiled cassava KM94 leaves in the DM, respectively.

<sup>2</sup> Ileal digestible lysine or methionine calculated based on the analysed crude protein and amino acid composition and apparent ileal digestibility data of Nguyen et al. (2011a) and Ngoan and Lindberg (2001).

<sup>3</sup> The four diets was added 5 g premix/kg DM. Composition per kg premix: 2,400 mg retinol; 4.32 cholecalciferol, 15,000 mg  $\alpha$ -tocopherol, 5,000 mg phytylmenaquinone, 2,000 mg thiamin; 15,000 mg riboflavin, 25,000 mg calcium pantothenate, 30,000 mg niacin, 30 mg cyanocobalamin, 2,000 mg folic acid, 100 mg choline, 100 mg Fe, 115 mg Zn, 40 mg Cu, 0.15 mg Co, 0.6 mg I, 0.3 mg Se.

$$\begin{aligned} \text{Lean mass (Ib)} \\ = 7.231 + [\text{hot carcass weight (Ib)} \times 0.437 \\ + (\text{loin area (Inch}^2) \times 3.877) \\ - [\text{P}_2 \text{ backfat thickness (Inch)} \times 18.746] \end{aligned}$$

$$\text{MEp} = \text{F} \times 53 + \text{P} \times 53$$

Where MEp is the metabolizable energy used for fat and protein deposition, F is the amount of fat deposited and P is amount of protein deposited.

### Protein and fat deposition calculation

To calculate the approximate protein and fat deposition, the following assumptions were made: one gram of protein and fat contains 23.4 kJ and 39.7 kJ of energy, respectively (NRC, 1998) and

$$\text{ME intake} = \text{ME}_{\text{m}} + \text{ME}_{\text{p}}$$

$$\text{ME}_{\text{p}} = c \times \text{protein deposition} + d \times \text{crude fat deposition}$$

Where ME<sub>m</sub> is the amount of ME required for maintenance (460 kJ of ME per kg of metabolic BW (BW<sup>0.75</sup>)), ME<sub>p</sub> is the metabolizable energy used for fat and protein deposition with c and d representing the amount of energy in kJ ME needed for the deposition of 1 g of protein and fat, respectively. The required amount of ME per g of protein and fat deposition was assumed to be 53 and 53 kJ per g (NRC, 1998).

On the basis of the study by Kotarbinska and Kielanowski (1969), it can be assumed that about 10% of the average daily gain (ADG) in the type of pigs used in the present study is gut fill and ash, thus, 0.9\*ADG = water+crude protein+crude fat.

The deposition rate of protein and fat in the empty body of the two genotypes were calculated base on the two following equations:

$$0.9 \times \text{ADG} = \text{F} + \text{P} / 0.21$$

where ADG is average rate of gain (g/d), 0.21 is protein/(protein+water), F is the amount of fat deposited (g/d); P is the amount of protein deposited (g/d) and

### Statistical analysis

Analyses of variance were performed according to the following model:

$$Y_{ij} = \mu + U_j + T_i + e_{ij}$$

where Y is a dependent variable,  $\mu$  is the overall mean, U<sub>j</sub> is the unit effect (j = 1, 2...5), T<sub>i</sub> is the treatment effect (I = 1, 2...4) and e<sub>ij</sub> is the random error.

Data were analyzed by ANOVA using the General Linear Model (GLM) of Minitab Statistical Software Version 14 (2004). Tukey pair-wise comparisons were used to determine differences between treatment means at p < 0.05.

## RESULTS

### Final live weight, average daily gain and feed conversion ratio

The performance data are given in Table 3. Results show that there were no significant differences in final live weight among the pigs fed the different experimental diets (Table 3). However, increased levels of ensiled cassava KM94 leaves tended to decrease final live weight of pigs (p = 0.071).

There was a significant decrease in average daily gain (ADG) with an increase in inclusion levels of ensiled cassava KM94 leaves (p = 0.022). The ADG were 561, 540, 523 and 511 g/d for pigs fed the FM, 10KM94, 15KM94 and 20KM94 diets, respectively. There was no significant difference in the mean DM intake of the pigs on the different experimental diets (p = 0.100). The data in Table 3

**Table 3.** Effect of using ensiled cassava KM 94 leaves in the diet on performance and economics of F1 crossbred (Large White×Mong Cai) pigs in Vietnam

	FM <sup>1</sup>	10KM94	15KM94	20KM94	SEM	p
Initial BW (kg)	23.4	23.2	23.8	23.7	0.2	0.339
Final BW (kg)	73.9	71.8	70.9	69.7	1.1	0.071
ADG (g/d)	561 <sup>a</sup>	540 <sup>ab</sup>	523 <sup>ab</sup>	511 <sup>b</sup>	11	0.022
DMI (kg DM/pig/d)	1.57	1.57	1.56	1.53	0.01	0.100
FCR (kg DM/kg gain)	2.81	2.92	3.03	3.02	0.08	0.197
Feed cost <sup>2</sup> (VND/kg gain)	8,134 <sup>a</sup>	7,386 <sup>ab</sup>	7,142 <sup>ab</sup>	6,638 <sup>b</sup>	189	0.001
Relative to control (%)	100	91	88	82	-	-

<sup>1</sup> FM = Fish meal diet; 10KM94, 15KM94 and 20KM94 contain 10, 15 and 20% ensiled cassava KM94 leaves in the dry matter (DM), respectively.

<sup>2</sup> Price (Viet Nam Dong (VND)/kg) of fresh feed in Hue at the time of the experiment: Ensiled cassava root (ECR): 500; Rice bran: 2,400; Maize: 2,700; Fish meal: 7,000; Sweet potato vines (SPV): 500; 1US\$ = 15,800 VND at the time of the experiment.

SEM = Standard error of the mean; LWG = Live weight gain.

Means with different letters (a, b) within rows differ (p < 0.05).

**Table 4.** Effect of inclusion level of ensiled KM94 cassava leaves in diets on the carcass characteristics of F1 crossbred (Large White × Mong Cai) pigs in Vietnam

Parameter	FM <sup>1</sup>	10KM94	15KM94	20KM94	SEM	p
Hot carcass without head (kg)	49.7	48.8	48.7	47.2	0.6	0.118
Dressing percentage (%)	67.9	68.8	67.9	68.2	0.4	0.623
Carcass length (cm)	75.3	73.7	73.6	74.7	1.9	0.904
Loin muscle area (cm <sup>2</sup> )	25.4	24.8	23.6	24.1	0.2	0.076
Back fat thickness P <sub>2</sub> (cm)	3.1	2.9	2.9	3.0	0.1	0.553
Calculated lean meat (%)	43.6	44.2	43.7	43.3	0.6	0.780

<sup>1</sup>FM = Fish meal diet; 10KM94, 15KM94 and 20KM94 contain 10, 15 and 20% ensiled cassava KM94 leaves in the DM, respectively. n = 3 for each diet. SEM = Standard error of the mean.

show that the feed conversion ratios (FCR) were not significantly ( $p = 0.197$ ) different between the pigs fed the different levels of ensiled cassava KM94 leaves although a numerical increase in FCR with KM94 inclusion level was observed (2.81, 2.92, 3.03 and 3.02 kg DM/kg gain). There were significant ( $p = 0.001$ ) differences in feed cost per kg live weight gain among treatments. The feed cost for the 20KM94 diet was lowest among the diets ( $p < 0.05$ ). Using 10, 15 and 20% ensiled cassava KM94 leaves reduced the feed cost by 9, 12 and 18%, respectively.

No significant ( $p > 0.05$ ; Table 4) treatment effects were found for any of the carcass trait.

Loin muscle area of the pigs fed the control, 10KM94, 15KM94 and 20KM94 diet were 25.4, 24.8, 23.6 and 24.1 cm<sup>2</sup>, respectively. Lean meat of these pigs was 43.6, 44.2, 43.7 and 43.3%, respectively. The content of lean meat did not decrease with increased level of ensiled KM94 in the diet.

No significant ( $p > 0.05$ , Table 5) treatment effects were observed for the estimated fat and protein deposition of the F1 pigs. Protein deposition of the F1 pigs tended ( $p = 0.093$ ) to decrease as the levels of ensiled cassava KM94 leaves increased in the diet. Protein deposition of the FM, 10KM94, 15KM94 and 20KM94 diets were 71.7, 66.0, 62.5 and 61.2 g/d, respectively.

## DISCUSSION

New high-yielding cassava varieties, such as KM94, KM98-5 and KM140 have been distributed to various provinces in Vietnam. More than 350,000 ha of new varieties, mainly KM94 were planted in 2007 (GSO, 2008). Cassava leaves of KM94 variety have a CP content of 25-

34.7% in DM and is a good source of protein for animals because of its amino acid composition (Ravindran, 1993; Phuc et al., 2001; Kinh, 2003; Ly and Ngoan, 2007). The greatest limitation to the use of fresh cassava KM94 leaves as animal feed is its very high HCN content. Sun-drying is probably the cheapest method in the tropics and is also the most effective method (Cardoso et al., 2005; Chauynarong et al., 2009; Wanapat, 2009) for reduction of the HCN content in cassava. However, the harvest season of cassava root in Vietnam coincides with the rainy season making sun drying often impossible. Ensiling is another method which is nearly as good as sun-drying for leaf preservation and reducing the HCN content (Man and Wiktorsson, 2001; Phuc et al., 2001; Borin et al., 2005). In the present study, the HCN content of fresh cassava leaves (KM94) was 1745 mg/kg DM and after 90 days of ensiling it was only 10.4-13.2% of this initial level (Ly and Ngoan, 2007). When included in the 10 to 20% diets, the HCN contents of the diets was 16-52 mg/kg DM. This level is safe for inclusion by pigs since it is below the recommended safety level of 50 mg HCN/kg diet (Bolhuis, 1954).

In this study, we did not find significant differences in final weight, feed intake, feed conversion ratio and for any of the carcass traits among the experimental diets. We found however found a significant decrease in ADG with increasing level of ensiled cassava leaves inclusion and indicate that ensiled cassava KM94 leaves can be used in the diets of pig diets although it leads to some reduction in daily gain. In addition to the depression in ADG the calculated protein gain also tended to decrease with increasing cassava leaves intake. Fat deposition of F1 pigs were not affected by dietary treatments. The ADG of pigs on the ensiled cassava KM94 leaves diets decreased

**Table 5.** Effect of inclusion level of ensiled KM94 cassava leaves in diets on protein and fat deposition of F1 crossbred (Large White × Mong Cai) pigs between 70-75 kg

Deposition	FM <sup>1</sup>	10KM94	15KM94	20KM94	SEM	p
Protein (g/d)	71.6	66.4	62.5	62.1	3.1	0.093
Fat (g/d)	162.7	172.6	173.4	168.4	5.5	0.502

<sup>1</sup>FM = Fish meal diet; 10KM94, 15KM94 and 20KM94 contain 10, 15 and 20% ensiled cassava KM94 leaves in the DM, respectively. SEM = Standard error of the mean.

with the level of inclusion. On the basis of a previous experiment (Nguyen et al., 2011b), it is clear that some supplemental methionine may be required in a diet with ensiled cassava leaves to have the same performance as the low inclusion levels as the likely reason for the decrease in performance is likely a shortage of the first limiting amino acid. The ileal digestible lysine and methionine in both periods of the 15KM94 and 20KM94 diets was lower compared to the FM and 10KM diets. It may also be that lysine was limiting. In addition, the reduced growth rate of the pigs on the 20KM94 diet may potentially have been due to the HCN content in the diet which was 50-52 mg HCN/kg DM. Some methionine in this diet may have been used for detoxification of the HCN. According to Tewe (1992), methionine will provide sulfhydryl groups (-SH) which are necessary for the detoxification of cyanide. In the body cyanide is detoxified by the enzyme rhodanese, forming thiocyanate, which is excreted in the urine.

In this study, we found that there were similar values for carcass traits among the experimental diets. This result is in good agreement with Van An et al. (2005) who also reported similar carcass traits of F1 (Large White×Mong cai) pigs which were fed diets with sweet potato leaves. These authors concluded that sweet potato leaves can replace fish meal and groundnut cake in traditional Vietnamese diets for growing pigs. This agrees with Scipioni and Martelli (2001), who concluded that increasing the level of a forage (sugar beet- pulp) from 10 to 20% in the diet does not affect carcass traits of pigs. Differences in lean meat content were not significantly different between the treatments. This result is also in good agreement with Van An et al. (2005) who reported that lean meat percentage of F1 pigs were 43.6, 42.5, 42.6 and 43.4% when protein from fish meal, groundnut cake, ensiled sweet potato leaves or ensiled sweet potato leaves, respectively were used with added lysine. Ngoan et al. (2000) found that lean meat content was a 40.2% when using fish meal as a protein source in addition to cassava root meal and rice bran in the diet of F1 (Large White×Mong cai) pigs.

Lindberg and Anderson (1998) reported that including 10 and 20% of the forages white clover, lucerne, red clover and perennial rye grass barley diets for growing pigs resulted in reduced digestibility of organic matter, but increased the digestibility of crude fibre. These authors concluded that forage addition to the diet of pigs can be used to a limited extent as a protein source. Recently, Nguyen et al. (2010) also found that ensiled or dry cassava leaves and sweet potato vine can replace at least 70% of the protein from fish meal (or 35% of total diet CP) without large effects on performance and carcass traits of growing F1 (Large White×Mong cai) pigs. Feed cost per kg gain were reduced by 8-18% compared to the fish meal diet. In

the present study there were significant differences in feed cost/kg weight gain among treatments. This parameter was lowest for the KM94 diet which was not different from the other diets containing ensiled cassava KM94 leaves but significantly different from the control diet. Using 10, 15 and 20% of ensiled cassava KM94 leaves reduced the feed cost by 9, 12 and 18%, respectively. These results are in agreement with Phuc (2000) who concluded that cassava leaves can be used as a protein supplement in growing diets and that ensiled or dried cassava leaves are potentially useful feed resources in developing countries. However for optimal gain some addition of the amino acids methionine and lysine may be needed.

## CONCLUSION

Inclusion of ensiled cassava KM94 leaves in diets for growing pigs was shown to decrease average daily gain when included up to 20% of the diet. However, feed costs per unit of live weight gain were lowest on the highest inclusion level providing a more cost effective alternative for pig farmers in Vietnam and ensiling is a practical solution to conserving cassava leaves and reducing the HCN content during root harvest.

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