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Allzyme SSF supplementation improves the utilization of sweet potato (*Ipomoea batatas*) vine meal by growing pigs

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ABSTRACT

The effects of Allzyme SSF supplementation of sweet potato vine meal (SPVM) on the performance of growing pigs were investigated. A control diet based on fish meal and full-fat soybean as protein sources and diets containing 150 and 300 g/kg of SPVM with and without SSF were fed each to pigs in five replicates pens in a completely randomized design for a period of 84 days. There was no treatment effect ($P > .05$) on dry matter intake. The highest body weight gain was recorded on the SSF-supplemented SPVM groups ($P < .05$) and the lowest ($P < .05$) on the SPVM-based diets without enzyme. Dressing percentage and P₂ back fat thickness were not affected by dietary treatment ($P > .05$), but per cent ham was markedly reduced on the control compared with the enzyme-supplemented SPVM diets ($P < .05$). The relative weight of digesta in the stomach and small intestine was not affected by the diet ($P > .05$). Allzyme supplementation significantly reduced digesta weight in the large intestine ($P < .05$) even at 30% dietary SPVM. It was concluded that supplementation of the diet with Allzyme SSF will improve the utilization of up to 30% SPVM by grower pigs, reduce cost of pork production and add value to this by-product.

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1. Introduction

Pork is among the most relished meats in the South Pacific region, but its supply is constrained by the high cost of feed ingredients. Conventional feed ingredients (energy and protein sources) are very expensive in the region. This calls for more research into the feeding value of locally available feed materials.

Sweet potato (*Ipomoea batatas*) is an important root crop mainly grown for food (Kunstelj et al. 2013). Sweet potato leaves and vines are moderate to good sources of protein ranging from 26% to 33% (Woolfe 1992; Dung 2001; An et al. 2003) with the protein having a good amino acid composition (Ishida et al. 2000; NCR 2012) but high in fibre content (Teguia et al. 1997; Ly et al. 2010). Currently, the leaves and vines from sweet potato harvest have limited use in the South Pacific region. There is literature on the feeding of sweet potato leaves/vines in pig diets (Phuc and Lindberg 2001; Ly et al. 2010), but exogenous enzyme supplementation of sweet potato vine meal (SPVM)-based diets for growing pigs is not reported. The present study evaluated SPVM with and without Allzyme SSF[®], an enzyme product with seven enzyme activities (amylase, cellulase, phytase, xylanase, beta-glucanase, pectinase and protease) for growing pigs.

2. Materials and methods

2.1. Preparation of SPVM

Sweet potato leaves with vines were collected from the harvest of a 5-month-old potato field, chopped using a knife and sun-

dried for 3 days. The sun-dried material was then ground to pass through a 2 mm sieve and labelled SPVM. SPVM was analysed for proximate composition, amino acid profile and non-starch polysaccharide (NSP) content (Table 1).

2.2. Experimental diets and pigs

A control diet based on fish meal and FFSB as protein sources and diets containing 150 and 300 g/kg SPVM with and without Allzyme SSF were formulated (Table 2). The diets contained ~15% crude protein, 1% lysine and 0.6% methionine. Allzyme SSF from Alltech with seven enzyme activities (amylase, cellulase, phytase, xylanase, beta-glucanase, pectinase and protease) was added at the rate of 300g/ton of feed.

A total of 50 crossbred (Landrace × Yorkshire) grower pigs with an initial weight of 25 ± 1.258 kg were housed in pairs in 25 standard size concrete pig floor pens. Each diet was fed *ad libitum* to pigs in 5 pens in a completely randomized design for a period of 84 days. The experimental protocol was approved by the animal ethics committee of the University of the South Pacific.

2.3. Measurements

Data were collected on growth and feed utilization, carcass traits and digesta weight in the gastro-intestinal tract segments. Growth and feed consumption data were collected per pen. Weight gain was calculated by the difference between the

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Table 1. Proximate composition and amino acid content of fish meal, full-fat soybean (FFSB) and SPVM (g/kg DM).

Constituents	Fish meal ^a	Full-fat ^a soybean	SPVM
DM	960	970	930
Crude protein	581	345	270
Ether extract	124	187	58
Crude fibre	6	144	210
Total NSP	ND	203	557
Insoluble NSP	ND	171	367
Soluble NSP	ND	18	139
Lysine (mg/100 mg DM)	3.51	2.2	1.14
Methionine (mg/100 mg DM)	1.2	0.56	0.62
^b ME (MJ/kg)	13	15.3	10.2

Note: SPVM: sweet potato vine meal; ND: not determined.

^aValues adapted from Devi (2016).

^bCalculated values.

Table 2. Ingredients and calculated composition of the experimental diets (g/kg).^a

Ingredient (g/kg)	Control		Potato vine + Allzyme		
	Potato vine		Potato vine	Allzyme	
Maize	542	469.5	397	469.5	397
Wheat middling	275.5	224.8	168.5	224.8	168.5
Fish meal	75.5	67.5	56.5	67.5	56.5
Full-fat soybean	69	50.2	40	50.2	40
Sweet potato vine meal	–	150	300	150	300
Coral sand	30	30	30	30	30
Salt	5	5	5	5	5
Lysine	2	2	2	2	2
Methionine	1	1	1	1	1
Allzyme SSF	–	–	–	0.3	0.3
<i>Calculated composition (%)</i>					
Crude protein	15	14.8	14.7	14.8	14.7
Lysine	1.04	1.02	0.98	1.02	0.98
Methionine	0.64	0.65	0.67	0.65	0.67
Total NSP	1.4	9.4	17.5	9.4	17.5
Insoluble NSP	1.2	6.4	11.7	6.4	11.7
Soluble NSP	0.2	3	5.8	3	5.8
^a ME (MJ/kg)	14.37	14.03	13.8	14.03	13.8

^aCalculated values.

initial and final body weights. Feed consumption was calculated as the difference between the quantity fed and the left over and feed conversion ratio (FCR) as feed consumed to weight gained. At the end of the experiment all pigs were fasted overnight, stunned electrically and slaughtered for carcass and digesta content measurements. Slaughtered pigs were scalded at 65°C for 5 min, dehaired and eviscerated. Dressed carcasses (including head and trotters) were weighed and expressed as percentages of the slaughter weight. The P2 back fat thickness of the carcass was measured at 10 cm from the midline behind the 10th rib using a ruler. The stomach, small intestine and large intestine were weighed full and empty to account for the

weight of digesta which was also expressed as percentage of the slaughter weight.

2.4. Chemical analysis

Dry matter was determined after 24 h in a forced-air oven (103°C). Nitrogen was analysed by the Kjeldahl method (AOAC 1990, ID 954.01) and crude protein calculated as $N \times 6.25$. Fat and fibre contents were analysed according to AOAC (1990, ID 942.05 and 962.09, respectively). NSP was analysed according to AOAC (1990, ID 991.43). Amino acid profile was determined using the Standard AAA hydrochloric acid hydrolysis followed by RP-HPLC separation using AccQ-Tag derivatization (AOAC 1990, ID 994.12).

2.5. Statistical analysis

Growth, carcass and gut data were subjected to one-way ANOVA (Steel and Torrie 1980) using the general linear model of SPSS (Statistical Package for Social Sciences, version 22). Pen was the experimental unit for feed consumption, whereas body weight, carcass traits and gut data were taken from individual pigs. Significant differences were reported at 5% level of probability.

3. Results

3.1. Chemical analysis

The analysed and calculated compositions of fish meal, FFSB, SPVM and the diets are presented in Tables 1 and 2. SPVM was characterized by higher NSP, lower ME and lysine contents, but slightly better methionine than FFSB. Dietary protein, lysine and methionine were kept similar, but ME was reduced and NSP was increased with the inclusion level of SPVM.

3.2. Growth performance and carcass data

The results of growth and carcass measurements (Table 3) showed no treatment effect ($P > .05$) on dry matter intake (DMI). The highest body weight gain was recorded on the SSF-supplemented SPVM groups. Weight gain was depressed ($P < .05$) on the SPVM-based diets without enzyme. Dressing percentage and P₂ back fat thickness were not affected by dietary treatment ($P > .05$), but per cent ham was markedly

Table 3. Growth performance and carcass measurements of pigs fed different levels of SPVM with and without Allzyme SSF.

Parameters	Control	Potato vine		Potato vine + Allzyme		s.e.m.	P-value
		15	30	15	30		
DMI (kg)	1.50	1.65	1.47	1.53	1.70	0.087	0.327
DWG (kg)	0.47 ^b	0.42 ^{bc}	0.40 ^c	0.57 ^a	0.61 ^a	0.044	0.042
FCR	3.2 ^a	3.92 ^a	3.68 ^a	2.68 ^b	2.83 ^b	0.264	0.024
Feed cost (US\$/kg)	1.32	1.17	1.0	1.0	1.0	n.a	n.a
<i>Carcass traits</i>							
Carcass (%)	75	78.4	78.1	76.2	76.3	1.310	0.375
Ham (%)	20.4 ^c	24.9 ^{bc}	24.3 ^{bc}	32.2 ^a	29.9 ^{ab}	1.333	0.001
P2 back fat thickness (cm)	3.2	3.1	3.1	2.7	2.9	0.141	0.078
Feed cost (US\$/kg carcass)	5.63 ^a	5.85 ^a	4.7 ^{ab}	3.51 ^b	3.7 ^b	0.684	0.021

Note: Means within the row bearing different superscripts (a, b, c) are different ($P < .05$). DWG, daily weight gain.

Table 4. Relative weight of digesta in the gastro-intestinal tract segments.

Parameters	Control	Potato vine		Potato vine + Allzyme		s.e.m.	P-value
		15	30	15	30		
Stomach	5.4	5.1	4.3	4.9	4.7	0.512	0.662
Small intestine	4.3	4.5	3.9	4.7	4.3	0.546	0.851
Large intestine	3.6 ^a	3.8 ^a	3.8 ^a	2.4 ^b	2.4 ^b	0.447	0.048

Note: Means within the row bearing different superscripts (a, b) are different ($P < .05$).

reduced on the control compared with the enzyme-supplemented SPVM diets ($P < .05$).

3.3. Weight of digesta in the gastro-intestinal tract

The relative weight of digesta in stomach and small intestine (Table 4) was not affected by the diet ($P > .05$). Allzyme supplementation significantly reduced digesta weight in the large intestine ($P < .05$) even at 30% dietary SPVM.

4. Discussion

4.1. Chemical composition

The lysine and methionine contents of the sweet potato leaf meal used in this study are similar to values (1.08% and 0.54%, respectively) reported in ensiled (An et al. 2003), but were higher than the values 0.83% and 0.43% (Ly et al. 2010); 0.62 and 0.26% (Farrell et al. 2000) in dry sweet potato leaf meal. An et al. (2003) and Ly et al. (2010) harvested leaves from 60 d-old-sweet potato plants, whereas Farrell et al. (2000) pruned the vines at regular intervals from a range of cultivars. Tegua et al. (1997) also reported a lower (~17%) crude fibre in dry sweet potato leaf meal than the value in the present study. Differences in the age of the leaves, the cultivar and vine:leaf ratio and processing method may all be possible factors in the variation in the composition. Edaphic and agronomic conditions, which have also been reported to affect the composition of cassava leaf (Eggum 1970; Ravindran 1991), may also be reasons for variability in the composition of sweet potato leaf meal. Potato vine meal contained more NSP, which was reflected in the diets as SPVM level increased.

4.2. Growth performance and carcass traits of the pigs

Similar to our findings, Ly et al. (2010) also observed no statistical effect of 20% dietary SPLM on DMI, daily weight gain (DWG) and FCR in young pigs. SPVM has a good protein quality, but its poor utilization by monogastric animals is due to the fibre content. The reduced DWG on the 30% SPVM without enzyme and subsequent improvement with enzyme supplementation may be due, on the one hand, to the inability of the pigs to utilize this level of SPVM and higher hydrolytic activity of SSF on the other. This higher gain resulted in better FCR on the SSF-supplemented diets. Although not significant, DMI was slightly reduced on 30% SPVM without enzyme. The slight difference in intake probably coupled with poor digestibility due to higher insoluble NSP might be implicated in the poorer DWG on this diet. Poor digestibility of sweet potato vines in pigs has been reported by Dominguez and Ly (1997).

Although not measured in this study, it could be speculated that Allzyme supplementation might have improved digestibility, resulting in the heavier relative weight of ham on these diets. Higher DWG and better FCR on the 15% and 30% SPVM diets with enzyme resulted in lower cost per unit carcass.

4.3. Digesta weight in gut segments

The reason for the pattern of digesta content in the large intestine of the pigs was not clear, but probably due to faster transit of digesta in the upper tract to accumulate in the large intestine of non-enzyme-supplemented diets on the one hand and maximum utilization of feed with enzyme supplementation. The production of short-chain fatty acids during fibre fermentation in the pig's colon, which is reported to be involved in gastro-intestinal emptying (Cherbut et al. 1997), may also be speculated as a possible reason for this pattern of digesta weight.

5. Conclusion

It can be concluded from the results of this study that supplementation of the diet with Allzyme SSF will improve the utilization of SPVM by grower pigs up to 30% inclusion. Effective utilization of sweet potato vine in pig diets is an alternative way of value addition to this by-product in sweet potato producing areas. Further studies in higher levels of SPVM, enzyme product and level, cultivar of potato, age of the leaves, processing method, diet composition and pig age are recommended.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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