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Full Length Research Paper

Growing pigs fed cassava peel based diet supplemented with or without Farmazyme® 3000 proenx: Effect on growth, carcass and blood parameters

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36 growing pigs (average initial weight of 22.74 ± 0.88 kg) were allotted to three dietary treatment groups of 30%maize-based control diet and 30%cassava-peel-based diet supplemented with or without Farmazyme 3000 proenx. Each treatment had three replicates of 4 pigs/replicate (12 pigs/treatment) in a complete randomized design. The pigs were allowed *AD LIBITUM* access to the diets and water throughout the 42-day duration of the trial. The replacement of the 30% maize in the control diet with cassava peel resulted in increased bulkiness and crude fiber contents of the cassava peel-based diets, hence, lowered energy content. There was also a reduction in the dry matter intake of the pigs and the cost of feed per kg intake by 19.6 and 23.5% for the cassava peel based diet with and without Farmazyme inclusion, respectively. The replacement of the maize content of the control diet with cassava peel resulted in 23 to 24% reduction in the cost of feed per kg live weight gain of the growing pigs. Farmazyme resulted in enhanced utilization (P < 0.05) of the cassava peel-based diet in terms of the daily and overall weight gains as well as the serum total protein, albumin, urea and cholesterol. While the heamoglobin and red blood cell (RBC) of the pigs were significantly positively influenced by the inclusion of the enzyme, it had no effect on the packed cell volume (PCV). The blood minerals (Na, Ca, Cl and P), relative organ weights and dressing percentage of the pigs were neither affected by the cassava peel replacement nor the enzyme inclusion but for the kidney, where lower values were obtained both for the control and Farmazyme supplemented cassava peel-based diets. It could therefore be concluded that, inclusion of Farmazyme 3000 proenx enhanced utilization of the cassava peel-based diet thereby, resulting in performance results comparable to pigs fed the maize-based control diet.

Key words: Cassava peels, growing pigs, non-starch polysaccharides, exogenous enzyme, pig feeding.

INTRODUCTION

Cereal grains supply the bulk of livestock feed, especially for poultry and pigs. However, in developing countries like Nigeria, cereal grains are in high demand for human uses and the production has never been adequate to meet the need of the increasing population, consequently, there is little or no excess grain for livestock feed. When available, it is always very expensive. For instance, in the year 2005, the price of maize rose from about #30 to #70 per kilogramme (approx. $0.25 to $0.50). This continuous increase in the cost of conventional ingredients used in compounding livestock feed has necessitated intensive research into cheap alternative source of energy yielding

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Abbreviations: RBC, Red blood cells; **PCV,** packed cell volume; **WBC,** white blood cell.

unconventional ingredients. Since the monogastric livestock industry constitutes the largest consumer of comercial livestock feeds in Africa, it is imperative to find alternative feed resources to the expensive energy ingredients like the cereals.

Cassava (*Manihot esculenta*) is an all-season crop of the humid tropics and ranks among the top 10 food crops in the world (Oyebimpe et al., 2006). It is the highest supplier of carbohydrates among staple crops (FAO, 1995). Annual production estimate in Nigeria was 34 million tonnes in 2002 (FAO, 2002). Cassava roots contain 30 to 40% dry matter, more than most roots and tubers. This depends on factors such as variety, soil type, moisture, climatic conditions and the age of the root at harvest. Starch and sugar are the predominant components of the dry matter, approximately 90%, with starch being the most important (FAO, 2002). Although, the crude protein content of cassava root is 2 to 4% in dry matter, the true protein content is less than half this amount due to the fact that 50% of the nitrogen in the roots is in the form of non-protein-nitrogen. Furthermore, the available true protein is deficient in the sulphur-containing amino acids. The roots contain significant amounts of vitamins, particularly vitamin C, thiamine, riboflavin and niacin (FAO, 2002). Cassava products have been in use for a long time as an energy source in place of cereal grains for livestock (Eruvbetine et al., 2003).

Cassava peels continue to constitute waste in the cassava processing industry. It accounts for 10 to 13% of the tuber by weight (Oyebimpe et al., 2006). This is in spite of the potential of the by-product as an animal feedstuff (Iyayi and Losel, 2001). Tewe and Iyayi (1995) reported that, among the roots produced in Nigeria, cassava from which cassava peel is obtained constitute 20% of total tubers produced annually. Cassava peel meal could serve as a cheap source of energy for farm animals but should be fortified with additional protein source because of its low protein level (Obioha and Anikwe, 1982).

Considerable evidence has emerged for long of the possibility of using processed cassava peel as an energy source for pigs and poultry (Longe et al., 1977; Tewe, 1981; Iyayi, 1986). Higher inclusion of the by-product in monogastric feed or formulation of diets with cassava peels, as sole energy source is limited because of its fibrous nature. Fakolade (1977) and Arowora et al. (1999) have reported the occurrence of high amounts of non-starch polysaccharides (NSPs) in cassava peels. Degradation of these carbohydrate compounds to simple sugars will further increase the energy value of cassava peels, hence, the need for the addition of exogenous enzymes when utilized in replacing cereals in diets for monogastric animals (Adesehinwa, 2004). The aim of this study therefore, is to determine the effect of cassava peel supplemented with or without Farmazyme 3000 proenx as a replacement for maize in the diets of growing pigs on the growth, some carcass traits, serological and heamatological indices of growing pigs.

MATERIALS AND METHODS

The utilization of cassava peel based diet supplemented with or without Farmazyme 3000 proenx (protease, fungal xylanase, fungal β-gluconase, endo β-gluconase, α-amylase, β-gluconase (pH 7.5-30°C), β-gluconase (pH 5-30°C), hemicellulase, pentozanase, pectinase) for growing pigs was investigated using 36 growing pigs, with average initial weight of 22.74 ± 0.88. The pigs were allotted to three dietary treatment groups of (1) 30% maize-based control diet, (2) 30% cassava-peel-based diet without Farmazyme inclusion and (3) 30% cassava-peel-based diet supplemented with Farm-azyme 3000 proenx, as shown in Table 1. Cassava peels of mixed varieties were obtained within 24 h after peeling from a cassava processing industry in Ibadan, Nigeria. They were then sun dried for 5 days under intensive sunshine to constant weight and ground in a hammer mill before being incorporated in the experimental diets. The maize content of the maize-based control diet was totally replaced with cassava peel on weight for weight basis in the two treatment diets. Each treatment had 12 pigs, comprising three replicates (with four pigs per replicate) in a complete randomized design. The pigs were allowed *ad libitum* access to the diets and water served in concrete feeding and watering troughs, respectively. The growth and economy of production were monitored throughout the 42-day duration of the trial.

At the end of the trial, two pigs were randomly selected from each replicate for bleeding. 10 ml of blood was obtained from the jugular vein of each of the pigs into two sample bottles for serological, heamatological and blood mineral analyses (Kaneko, 1989) using a sterilized needle and syringe. Some carcass and organ weights were also taken from two pigs randomly selected per replicate for this purpose. The pigs were starved of feed for 16 h, weighed and slaughtered. The slaughtered pigs were properly bled, cleaned and eviscerated before dissecting into parts and weighed.

All the data obtained were subjected to analysis of variance and where statistical significance was observed, the means were separated using the Duncan's multiple range (DMR) test. The SAS computer software package (SAS, 1999) was used for all statistical analysis.

RESULTS AND DISCUSSION

Effect on growth and feed conversion

Proximate composition of test ingredient (cassava peel) used and the formulated experimental diets is as shown in Table 2. The replacement of the 30% maize in the control diet with cassava peel resulted in increased bulk and crude fiber contents of the cassava peel-based diets (Table 2) hence, a lowered energy content is expected. The increased bulk could be said to be responsible for the reduction in the dry matter intake of the pigs fed the cassava peel based diet with and without Farmazyme® supplementation in line with the earlier findings of Adesehinwa et al. (2008a) inspite of the lowered energy content. There was a significantly ($P < 0.05$) lower quantity of feed consumed in the cassava peel-based diet treatments. Even though the gains and feed conversion of pigs observed in the cassava peel-based diets were

Table 1. Gross and proximate composition of diets fed to growing experimental pigs.

Ingredient	Maize-based	Cassava peel-based
Maize	30.00	0.00
Cassava peel meal	0.00	30.00
Palm kernel cake	30.00	30.00
Wheat bran	18.00	18.00
Groundnut cake	15.00	15.00
Fishmeal	2.00	2.00
Bone meal	3.00	3.00
Oyster shell	1.25	1.25
Salt	0.50	0.50
Vit-Min premix*	0.25	0.25

*Pfizer Agricare Grower Premix supplied the following per kg diet: Vit. A 10,000,000 IU; Vit. D_3 2,000,000 IU; Vit. E 8,000 IU; Vit K 2,000 mg; Vit B_1 2,000 mg; Vit. B_2 5,500 mg; Vit. B_6 1,200 mg; Vit. B_{12} 12 mg; Biotin 30 mg; folic acid 600 mg; Niacin 10,000 mg; pantothenic acid 7,000 mg; choline chloride 500,000 mg; Vit. C 10,000 mg; iron 60,000 mg; Mn 80,000 mg; Cu 8,00 mg; Zn 50,000 mg; Iodine 2,000 mg; cobalt 450 mg; selenium 100 mg; Mg 100,000 mg; anti oxidant 6,000 mg.

Table 2. Proximate composition of test ingredient and experimental diets (%).

Component	Maize-based diet	Cassava peel -based diet	Cassava peel
Dry matter	89.50	88.96	89.24
Crude protein	18.20	17.33	3.15
Crude fiber	5.50	9.89	33.96
Ether extract	4.67	3.61	0.34
Ash	6.57	7.13	1.44

Table 3. Performance characteristics and economy of gain of growing pigs fed diets with or without Farmazyme 3000 proenx inclusion.

Parameter	Cassava peel-based			SEM
	Maize-based	Without enzyme	With enzyme	(±)
Average initial weight (kg)	22.50	22.78	22.94	0.88
Average final weight (kg)	39.28	37.17	39.44	1.13
Average total weight gain (kg)	16.78[a]	14.39[b]	16.50[ab]	0.36
Average daily dry matter intake (kg)	1.63[a]	1.42[b]	1.49[b]	0.02
Average daily weight gain (kg)	0.40[a]	0.35[b]	0.39[ab]	0.36
Feed conversion (Feed : Gain)	4.51	4.65	4.20	0.13
Av cost of feed consumed/day (N)	46.16[a]	30.81[b]	34.03[b]	0.02
Av cost of feed per gain (N)	115.40[a]	88.03[b]	87.26[b]	0.05

a,b, Means along the same row with different superscripts are significantly ($P < 0.05$) different from each other.

to produce direct benefits of increase in body weight gain as a result of improved feed efficiency (Adesehinwa, 2008b). The final weights of the pigs were com-parable across the groups over the 42-day duration of the study, as shown in Table 3.

There was also a reduction of the cost of feed per kg by 23.5 and 19.6%, respectively, as a result of the replacement of the 30% maize in the control diet with cassava peel supplemented without or with Farmazyme inclusion (Table 3). The replacement of the maize content of the basal diet with cassava peel resulted in comparable feed: gain, but a significant ($P < 0.05$) reduction of 23 to 24% in

Table 4. Some carcass traits and relative organ weights of growing pigs fed diets with or without Farmazyme 3000 proenx inclusion.

Parameter	Maize-based	Cassava peel-based		SEM (±)
		Without enzyme	With enzyme	
Carcass				
Slaughter weight (kg)	42.88	42.88	43.00	0.52
Cold carcass weight (kg)	30.11	30.02	29.44	0.10
Dressing percentage (%)	70.18	69.95	68.41	0.79
Internal organs (%)				
Kidney	0.30^{b}	0.39^{a}	0.35^{ab}	0.02
Liver	2.28	2.45	2.23	0.05
Heart	0.38	0.41	0.43	0.02
Spleen	0.22	0.16	0.14	0.02

a,b, Means along the same row with different superscripts are significantly (P < 0.05) different from each other.

the cost of feed/kg live weight gain (N) for the growing pigs fed the cassava peel-based diets (Table 3). Farmazyme® resulted in enhanced utilization (P < 0.05) of the cassava peel based diet in terms of the daily and overall weight gains. Dale (1997) reported addition of enzymes to diets to produce not only direct benefits of increased body weight gain and improved feed con-version but also reduction in feed costs.

Effect on carcass and organ weights

The results of some carcass traits and relative organ weights of the growing pigs fed diets supplemented with or without Farmazyme 3000 proenx is as shown in Table 4. The dressing percentage of the pigs were com-parable across the groups showing that, the replacement of maize with cassava peel supplemented with or without the exogenous enzyme in the diets of growing pigs did not affect the resulting cold carcass weights of the pigs when slaughtered (Table 4). Addition of multi-enzyme, such as Farmazyme®, has been reported not to affect edible organ weights and carcass characteristics such as dressing percentages except for abdominal fat content which decreased with enzyme addition (Kilic et al., 2006). This was also in agreement with the findings of Johri (2004) and Torres et al. (2003) who also reported that, multi-enzyme addition did not affect carcass characte-ristics of broilers used in their study. In the present study, the relative organ weights of the pigs were neither affected by the cassava peel replacement nor the enzyme inclusion; but for the kidney, where lower values were obtained with the pigs on the control diet, the results were comparable (P > 0.05) to those on the cassava peel-based diet without enzyme supplementation (Table 4).

Effect on serum metabolites, hematological parameters and blood minerals

The inclusion of Farmazyme resulted in enhanced utili-zation of the cassava peel-based diet in terms of increased daily and overall weight gains, comparable to those of pigs on the maize-based control diet (Table 3). This also resulted in comparable values of serum total protein, albumin and urea obtained for the two groups (Table 5). This indicated that the protein levels of the maize-based diet and the cassava peel based diet supplemented with Farmazyme® was able to support the protein reserves of the pigs across the groups. The urea levels of pigs fed the cassava peel-based diet supple-mented with Farmazyme was also comparable (P > 0.05) to those of pigs on the maize-control but signifi-cantly lower (P < 0.05) compared with those of pigs fed with cassava peel-based diet without enzyme supple-mentation (Table 5).

High serum urea has been reported as an indicator of muscular wastage in animals (Adesehinwa, 2008). In spite of the high fiber content of the cassava peel-based diets (cassava being highly fibrous), the diets seemed to have been efficiently utilized similar to the maize-based, thereby, resulting in high tissue deposition (Adesehinwa, 2007) in pigs fed with both diets compared with the cassava peel-based diet without enzyme supple-mentation. The least cholesterol level was recorded for the enzyme supplemented diet, in line with the findings of Kilic et al. (2006), who reported that enzyme significantly (P < 0.05) influence fat deposition in broilers. It could be observed that, the urea levels were inversely proportional to the live weight gains of the growing pigs (Table 5).

The hemoglobin and red blood cells (RBC) of the pigs were significantly (P < 0.05) increased by the inclusion of the enzyme, as the replacement of the maize content of

Table 5. Hematological parameters, serum metabolites and blood minerals of growing pigs fed diets with or without Farmazyme 3000 proenx inclusion.

Parameter	Maize-based	Cassava peel-based: Without enzyme	Cassava peel-based: With enzyme	SEM (±)
Heamatology				
Packed cell volume (PCV) %	42.95^{a}	39.92^{b}	40.95^{b}	0.29
Heamoglobin (Hgb) g/dl	14.13^{a}	12.37^{c}	13.48^{b}	0.12
Red blood cell (RBC) $x10^{6}$/µl	7.17^{a}	5.97^{b}	6.95^{a}	0.07
White blood cell (WBC) $x10^{3}$/µl	8.63	8.75	8.40	0.15
Serum metabolites				
Total protein (g/dl)	6.95^{a}	6.23^{b}	6.77^{a}	0.07
Albumin (g/dl)	3.13^{a}	2.70^{b}	2.98^{a}	0.05
Urea (mg/dl)	12.65^{b}	14.55^{a}	13.07^{b}	0.17
Creatinine (mg/dl)	1.57^{a}	1.07^{b}	1.12^{b}	0.05
Cholesterol (mg/dl)	124.15^{a}	113.03^{b}	102.65^{c}	1.06
Glucose (mg/dl)	92.02	87.02	90.55	0.68
Minerals				
Sodium (Na) MEq/l	144.27^{a}	141.27^{b}	142.40^{ab}	0.38
Potassium (K) MEq/l	5.32	4.98	5.37	0.1
Calcium (Ca) mg/dl	10.18^{a}	9.53^{b}	10.37^{a}	0.10
Chlorine (Cl) MEq/l	98.63^{b}	101.92^{a}	99.28^{b}	0.30
Phosphorus (P) mg/dl	7.47^{a}	6.62^{b}	7.97^{a}	0.14

a,b,c = Means along the same row with different superscripts are significantly ($P < 0.05$) different from each other.

the basal diet with cassava peel significantly reduced both parameters. The enzyme had no effect on the packed cell volume (PCV) of the pigs, hence, the PCV of the pigs on the maize-control diet were significantly higher than those on the cassava peel-based diets (Table 5). The white blood cell (WBC) values observed in this study were not significantly influenced by both treatments (cassava peel and enzyme inclusion). The enzyme had significant effect ($P < 0.05$) on all the blood minerals measured in this study but for K, resulting in values comparable to those of pigs on the maize-based control dietary group (Table 5).

Conclusions

It could be concluded that, even though the replacement of maize with cassava peel had no adverse effect on the dressing percentage and other parameters in some instances, inclusion of Farmazyme 3000 proenx enhanced utilization of the cassava peel-based diet better; resulting in better performance comparable to pigs fed with the maize-based control diet. The result of this study therefore indicates that, the cassava peel meal, which is economically cheaper than maize and regarded as waste in some areas of Nigeria can be used successfully to replace maize in conventional pig feed without any depression or adverse effect on the growth performance, health status and carcass characteristics.

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