PJN

ISSN 1680-5194

PAKISTAN JOURNAL OF NUTRITION

ANSInet

308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Mob: +92 300 3008585, Fax: +92 41 8815544

E-mail: editorpjn@gmail.com

Pakistan Journal of Nutrition 5 (5): 461-466, 2006
ISSN 1680-5194

Response of Weaner Pigs to Diets of Different Proportions and High Levels of Palm Kernel Meal and Brewers Dried Grain in the Humid Tropics

K.U. Amaefule*, S.N. Ibe, S.F. Abasiekong and O.C. Onwudike
College of Animal Science and Animal Health, Michael Okpara University of Agriculture, Umudike, PMB 7267, Umuahia, Abia State, Nigeria

Abstract: The response of weaner pigs to diets of different proportions and high levels of palm kernel meal (PKM) and brewers dried grain (BDG) in the humid tropics was determined with 24 hybrid (Landrace x Duroc) pigs whose initial live weights ranged from 8.08 to 8.21 kg (average 8.18 kg). The different proportions of PKM + BDG in the diets were 30 + 40% (T2), 35 + 35% (T3), and 40 + 30% (T4), respectively. PKM + BDG was 0% in T1 (control) and replaced maize in diets T2, T3 and T4. Growth performance and cost-benefit were evaluated at the weaner stage, while carcass and organ characteristics were added at the end of grower stage. Parameters measured were live weight, weight gain, feed intake, feed conversion ratio (FCR), protein efficiency ratio (PER), feed cost, feed cost of weight gain, gross margin, carcass and organ characteristics. Diets of different proportions of PKM and BDG significantly ($P<0.05$) increased FCR and protein intake, significantly ($P<0.05$) reduced cost of production and increased gross margin at the weaner stage. At the grower stage, PKM+BDG diets significantly ($P<0.05$) lowered final live weight, weight gain, PER and significantly ($P<0.05$) increased FCR, feed and protein intake. The diets also significantly ($P<0.05$) reduced total feed cost compared to the control diet and affected some carcass and organ characteristics without regular pattern. It was concluded that weaner and grower pigs could be fed diets containing 70% PKM + BDG (at various proportional combinations), replacing maize completely in the diets.

Key words: Diets, brewers dried grain, palm kernel meal, weaner pigs

Introduction

The supply of animal protein to the average Nigerians, especially low-income and non-wage earners could be increased by paying greater attention to the production of pigs. Unfortunately, increased pig production is being hampered; *inter alia* by high cost of maize, soybean meal, groundnut cake and fish meal, which are also consumed by humans. In order to encourage pig production, there is need to source alternative feedstuffs for which there is no competition with humans, and which are relatively cheap for pig feeding. Agro-industrial by-products like palm kernel meal (PKM) and brewers dried grain (BDG) are in this category.

PKM contains about 14-21% CP, 10-20% CF (Olomu, 1995). The first limiting amino acid in PKM is methionine (McDonald *et al*., 1995) while the contents of lysine, histidine and threonine are low (Olomu, 1995). Final live weight of pigs decreased linearly with increase in level of PKM from 21 to 62% (Jegede *et al*., 1994) while on the contrary; Ekenyem (2002) stated that various graded levels (20, 30, 40 and 50%) of PKM had no significant effect on the intake and performance of pigs. BDG contains about 19-25% crude protein, 10-22% crude fibre and gross energy value of 3030-3170 kcal/kg (Kwari *et al*., 1999; Oluponna *et al*., 2002; Amaefule *et al*., 2006a, b).

Since the agro-industrial by-products such as PKM and BDG are expected to replace part or the whole of the conventional feedstuffs, and thereby reduce the cost of feeding pigs, it is necessary to determine the nutritional value of the by-products in their various combinations. This study was therefore aimed at determining the response of weaner pigs to diets of different proportions and high inclusion levels of palm kernel meal and brewers dried grain in the humid tropics.

Materials and Methods

Experimental pigs: Twenty-four, 49-day old hybrid (Landrace x Duroc) weaner pigs whose initial live weights ranged from 8.08 to 8.21 kg (average 8.18 kg) were used in conducting this study. They were made up of equal numbers of intact males and females. The pigs had numbered ear tags for proper identification.

Experimental diets: The experimental diets were formulated in such a way that PKM and BDG constituted 70% of the whole diets T2, T3 and T4. Diet T1 (control) was maize-groundnut cake (GNC) based and contained no PKM or BDG (Table 1). The proportions of PKM and BDG were 30 and 40% in T2, 35 and 35% in T3, 40 and 30% in T4 diets, respectively. The diets were fortified with bone meal, salt and vitamin premix.

Housing and management of the pigs: The pigs were housed in a tropical-type and open-sided pig house roofed with asbestos roofing sheets (Amaefule *et al*., 2006a). The open sides of the building were covered with expanded metal to prevent illegal entry of persons and iron net to prevent flies and other insects. Each pen (2.96 m x 3.95 m) housed two pigs of a replicate. The pens had dwarf walls of 120 cm high separating them and concrete floors. There was a wallow (127 cm x 60 cm x 23 cm), feed (100 cm x 30 cm x 12 cm) and water (60 cm x 52 cm x 21 cm) troughs in each pen, all constructed with concrete, and a dunging area. The pigs were fed the experimental dry mash twice daily, in the morning (8.00-8.30 am) and afternoon (2.30-3.00 pm). The wallowing trough had water always while drinking water was provided *ad libitum*.

The pigs were treated against ecto- and endo-parasites with Ivomectin[R] injection prior to the start of the study. They were also given antibiotics (Tetracycline LA) injection to ensure good health.

Experimental design and data collection

Growth performance: The experimental design was completely randomized design (CRD). There were four treatments each replicated three times. Each replicate had two (intact male and female) pigs. Data was collected for two growth stages; weaner and grower stages although, there was no change in diets. The pigs were also not re-allocated. The weaner stage lasted 90 days and the grower stage 98 days.

The pigs were weighed at the start of the experiment and subsequently on a weekly basis. Weight gain was calculated as final live weight minus initial live weight. Feed intake was obtained as the difference between the quantity offered and quantity not consumed. Feed conversion ratio (FCR) was calculated as feed intake divided by weight gain.

Cost-benefit: The cost per kg of the diet was calculated by multiplying the percentage composition of the feedstuffs with the price per kg and summing all. Total feed intake multiplied by cost per kg feed gave total feed cost. Feed cost per kg weight gain was calculated as FCR x cost per kg of diet. Total feed cost was assumed to be 80% of total cost of production (Akinfala and Tewe, 2002). Gross margin was calculated as price per kg pork minus total cost of producing 1 kg of pork.

Carcass quality evaluation: The male pig from each replicate was used at the end of the experiment to evaluate the carcass quality and organ characteristic of pigs fed different proportions of PKM and BDG diets. Prior to slaughter, the pigs were fasted for 16 hours but given drinking water. They were stunned with a metal rod and bled completely. Water (normal temperature) was poured on the entire skin surface and the hairs removed with a surgical blade. The head, trotters, tail, intestinal contents and organs were removed. The remaining carcass was weighed with a 100 kg capacity weighing

Table 1: Percentage Composition of Diets of different proportions of PKM and BDG fed to weaner pigs

Feedstuffs	T1 (Control)	T2	T3	T4
White maize	35.00	0.00	0.00	0.00
Groundnut cake	20.00	10.00	10.00	10.00
Local fish meal	2.00	2.00	2.00	2.00
Palm kernel meal	0.00	30.00	35.00	40.00
Brewers dried grain	0.00	40.00	35.00	30.00
Maize offal	10.00	10.00	10.00	10.00
Wheat offal	19.00	4.00	4.00	4.00
Bone meal	3.50	3.50	3.50	3.50
Vitamin Premix*	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Total (%)	100	100	100	100
Calculated:				
CP (%)	18.65	21.00	20.85	20.70
ME ($MJKg^{-1}$)	11.44	8.63	9.61	9.76
CF (%)	4.34	12.96	12.56	12.16
Lysine (%)	0.56	0.86	0.85	0.84
Methionine (%)	0.28	0.39	0.39	0.39
Ca (%)	1.42	1.42	1.42	1.42
Avail. P (%)	0.59	0.59	0.59	0.59

*Contains per kg: Vit. A 10000 IU, Vit. B 2000 IU, Vit. E 13000 IU, Vit.K 1500 IU, Vit.B_{12} 10 mg, Riboflavin 5000 mg, Pyridoxine 1300 mg, Pantothenic acid 8000 mg, Nicotinic acid 2800 mg, Folic acid 500 mg, Biotin 40 mg, Copper 7 mg, Manganese 48000 mg, Iron 5800 mg, Zinc 58000 mg, Selenium 120 mg, Iodine 60 mg, Cobalt 300 mg, Choline 275000 mg.

balance (Goat[R] Brand) and expressed as a percentage of the live weight to obtain the warm dressing-out percentage. The fresh organs were also weighed using a sensitive top-loading balance (Aculab, 0.01g) and expressed as a percentage of the carcass weight. Back fat thickness was measured at the 1st and 4th ribs with Venier calipers. The carcass length was measured from the anterior edge of first rib to anterior edge of aitch bone.

Chemical and data analyses: Experimental diets, PKM and BDG were analyzed for proximate composition according to methods of A.O.A.C. (1990). Data on growth, live weight, and carcass quality and organ characteristics were subjected to analysis of variance (ANOVA) for completely randomized design. The values in percentages were subjected to Arcsine transformation before ANOVA while differences between treatment means were separated using Duncan's Multiple Range Test (Duncan, 1955). All other statistical procedures were according to Steel and Torrie (1980).

Results and Discussion

Proximate composition: The proximate composition of palm kernel meal (PKM) and brewers dried grain (BDG) (Table 2) showed that BDG had the higher crude protein, ether extract, crude fibre and crude ash levels than PKM. The proximate values were within the range earlier obtained by Olomu (1995), Kwari *et al.* (1999) and Amaefule *et al.* (2006a, b).

Table 2: Proximate composition of PKM, BDG and diets of different proportions of PKM and BDG (% DM Basis)

Composition	T1	T2	T3	T4	PKM	BDG
Dry matter (%)	91.00	90.50	90.89	90.50	89.70	89.50
Crude protein (%)	20.91	20.56	20.17	21.57	20.53	22.49
Ether extract (%)	6.10	5.75	5.95	6.05	6.15	6.25
Crude fibre (%)	5.00	13.10	13.50	13.35	16.25	21.00
Crude Ash (%)	7.80	9.20	7.05	9.80	4.30	4.70
Nitrogen Free Extract (%)	51.19	41.89	44.22	39.73	42.47	35.06

T1, T2, T3 and T4 = 0, 30%PKM+40%BDG, 35%PKM+35%BDG and 40%PKM+30% BDG diets, respectively. PKM = Palm kernel meal; BDG = Brewers dried grain.

Table 3: Performance of weaner pigs fed diets of different proportions of PKM and BDG

Parameters	T1	T2	T3	T4	SEM
Initial live weight (kg/pig)	8.08	8.29	8.13	8.21	0.49
Final live weight (kg/pig)	20.83	20.08	20.08	20.08	0.76
Daily weight gain (g)	141.67	131.00	132.85	131.93	5.35
Daily feed intake (g)	611.94	661.11	661.11	661.10	12.29
FCR	4.33^{b}	5.05^{a}	4.98^{a}	5.03^{a}	0.13
Daily Protein intake (g)	114.13^{b}	138.83^{a}	137.84^{a}	136.85^{a}	2.29
PER	1.24^{a}	0.94^{b}	0.97^{b}	0.96^{b}	0.03

a, b Means in a row with different superscripts are significantly different (P<0.05).
SEM = Standard error of mean. T1, T2, T3 and T4 = 0, 30%PKM+40%BDG, 35%PKM+35%BDG and 40%PKM+30% BDG diets, respectively. PKM = Palm kernel meal; BDG = Brewers dried grain.

Weaner stage

Growth performance: The growth performance of weaner pigs fed different proportions of PKM and BDG diets is presented in Table 3. There were no significant differences (P>0.05) among the weaner pigs fed the control and diets containing different proportions of PKM and BDG in final live weight, daily feed intake and daily weight gain. These parameters did not also differ among pigs fed different proportions of PKM and BDG diets. These results were despite the low energy content of T2, T3 and T4 diets (Table 1) and high crude fibre content of the diets (Table 2), which resulted from non-inclusion of maize and high levels of PKM and BDG in the diets. This confirms earlier reports (Kennelly *et al.*, 1978; Kennelly and Aherne, 1980) that the addition of fibre to pig's diet decreases the DE concentration of the diet, but this time with slight increase in feed intake in an attempt for the pigs to maintain DE intake (Agricultural Research Council, 1981; Low, 1985).

The comparable weight gain and final live weight of weaner pigs fed control diet with those fed different proportions of PKM and BDG diets, which were low in energy, may have been due to the low environmental temperature (20-21°C) obtained in the piggery house throughout the period of the experiment. Stahly (1984) had pointed out that low energy (high fibre) diets will support growth rates equal to those of pigs fed higher energy diets during periods of low environmental temperatures. Microbial fermentation of fibre in the large intestine may also have contributed to the maintenance energy requirement of the pigs (Kass *et al.*, 1980; Kennelly *et al.*, 1981).

The diets of PKM+BDG significantly (P<0.05) increased feed conversion ratio, protein intake and significantly reduced protein efficiency ratio when compared with the control diet. This may have been due to the minor differences in daily feed intake and protein content of the diets. The complete elimination of maize from the diets composed of different proportions of PKM and BDG, and the impressive performance of the weaner pigs showed that weaner pigs could be fed adequately without maize in their diets.

Cost benefit: The diets of different proportions of PKM and BDG significantly (P<0.05) reduced total feed cost, feed cost of weight gain, and total cost of production (Table 4). This was due to the lower cost per kg of the diets compared to the control diet. There were no significant differences (P>0.05) among the weaner pigs in all the cost-benefit parameters considered. These could have been due to the very minor differences in the cost per kg of the diets coupled with the similar intake values for the diets.

Diets of different proportions of PKM and BDG gave significantly (P<0.05) higher financial benefits (gross margin) than the control, which points out that a pig farmer would make more financial gain by feeding weaner pigs with diets formulated with up to 70% PKM and BDG, excluding maize completely in the diets.

Grower stage

Growth performance: Grower pigs fed different proportions of PKM and BDG diets had significantly (P<0.05) reduced final live weight and daily weight gain (Table 5), with higher reductions resulting from T3 (35% PKM and 35% BDG) and T4 (40% PKM and 30% BDG) diets. This could have resulted from the lower ME content (Table 1) of the diets, which may not have met

Table 4: The cost-benefit of feeding diets of different proportions of PKM and BDG to weaner pigs

Cost	T1	T2	T3	T4	SEM
Cost per kg feed (N)	33.43	21.23	20.53	19.83	-
Total feed intake (N)	56.13[b]	59.50[a]	59.50[a]	59.50[a]	0.84
Total weight gain (kg)	12.75	11.79	11.96	11.87	0.48
Total feed cost (N)	1876.54 [a]	1263.19[b]	1221.54[b]	1179.89[b]	28.14
Cost per kg weight gain (N)	144.87[a]	107.28[b]	102.24[b]	99.68[b]	2.84
Total cost of Production (N)	181.07[a]	134.10[b]	127.80[b]	124.60[b]	3.55
Price per kg Pork (N)	250.00	250.00	250.00	250.00	-
Gross margin (N)	68.91[b]	115.90[a]	122.20[a]	125.41[a]	3.55

a, b Means in a row with different superscripts are significantly different (P<0.05). SEM = Standard error of mean. T1, T2, T3 and T4 = 0, 30%PKM+40%BDG, 35%PKM+35%BDG and 40%PKM+30% BDG diets, respectively. $1.00 = N140.00; N = Naira. PKM = Palm kernel meal; BDG = Brewers dried grain.

Table 5: Performance of grower pigs fed diets of different proportions of PKM and BDG

Parameters	T1	T2	T3	T4	SEM
Initial live weight (kg)	20.83	20.08	20.08	20.08	0.76
Final live weight (kg)	37.08[a]	34.58[b]	31.42[c]	31.75[c]	0.53
Daily weight gain (g)	232.14[a]	197.62[b]	161.91[c]	166.67[bc]	10.31
Daily feed intake (g)	821.43[b]	964.29[a]	964.29[a]	964.29[a]	35.72
FCR	3.61[b]	4.92[a]	6.08[a]	5.78[a]	0.38
Daily Protein intake (g)	153.20[b]	202.50[a]	201.05[a]	199.61[a]	6.66
PER	1.55[a]	0.98[b]	0.80[b]	0.83[b]	0.11

a - c Means in a row with different superscripts are significantly different (P<0.05). SEM = Standard error of mean. T1, T2, T3 and T4 = 0, 30%PKM+40%BDG, 35%PKM+35%BDG and 40%PKM+30% BDG diets, respectively. PKM = Palm kernel meal; BDG = Brewers dried grain.

the energy requirement of the pigs (National Research Council, 1998). The lower energy and higher crude fibre contents (Table 2) of the diets may have equally caused the significant increase in the intake of the PKM+BDG diets (Low, 1985).

Pigs fed T2, T3 and T4 diets also had significantly (P<0.05) higher feed conversion ratio (FCR) and lower protein efficiency ratio (PER) than those fed control diets. These bear direct relationship to the weight gain and feed intake of the pigs (Table 5).

Generally, pigs fed T2 diet (30% PKM and 40% BDG) performed better than those fed T3 and T4 diets, pointing out that the appropriate proportional inclusion of PKM and BDG in grower pig's diet should be 30 and 40%, respectively. The results obtained in this grower stage include the carry-over effect of feeding the pigs with these diets from the weaner stage.

The performance of pigs in this study is lower than that obtained by Depres *et al.* (1994) with (Large white x Local) hybrid pigs fed *ad libitum* with commercial cereal-based (13.8MJ ME and 16% CP) feed. This could be attributed to the lower ME and lysine content of our diets, which did not meet the National Research Council (1998) standards for growing pigs. The genetic make-up of the pigs used in the study could also have caused the differences in performance (Litten *et al.*, 2004).

Cost-benefit: The feeding of different proportions of PKM and BDG diets to grower pigs significantly (P<0.05) affected only total feed cost (Table 6). Treatment 4 (40% PKM and 30% BDG) diet significantly (P<0.05) reduced the total feed cost more than T1 (control) and T2 diets. This was attributed to the lower cost per kg of T4 diet compared to T1 and T2, and to the difference in feed intake in relation to the control diet. There were no significant differences (P>0.05) among the pigs fed the experimental diets in other cost-benefit parameters considered. Despite this, the higher (numerical) financial benefit as result of feeding T2 (30% PKM and 40% BDG) diet would be of much interest to a pig farmer whose overall interest is higher profit.

Carcass quality and organ characteristics: Carcass quality as affected by diets containing different proportions of PKM and BDG is presented in Table 7. Dressed weight, ham, rib cage region, trotters, tail and back fat thickness were not significantly (P>0.05) affected by the various treatment diets. Rather, pigs fed T4 diet had significantly (P<0.05) higher percent shoulder and head than those fed the control diet. This could be attributed to individual differences inherent in the pigs in nutrient utilization for growth and also to the effect of diet. On the other hand, pigs fed control diet had significantly (P<0.05) higher loin and carcass length than those fed T3 and T4 diets, respectively. This could also be attributed to the differences among the pigs in the utilization of nutrients for growth and muscle tissue deposition.

The carcass quality of pigs fed the different proportions of PKM and BDG diets did not differ among each other in loin and carcass length. The results obtained in this study compare favourably with those of Obioha and Anikwe (1982) with cassava peel diets but were inferior to those of Gonzalez *et al.* (2002) with potato root meal.

Table 6: The cost-benefit of feeding diets of different proportions of PKM and BDG to grower pigs

Cost	T1	T2	T3	T4	SEM
Cost per kg feed (N)	33.43	21.23	20.53	19.83	-
Total feed intake (kg)	65.00[b]	67.48[a]	67.49[a]	67.49[a]	0.63
Total weight gain (kg)	16.25[a]	13.83[b]	11.33[c]	11.67[bc]	0.72
Total feed cost (N)	2172.95[a]	1433.03[b]	1385.78[bc]	1338.53[c]	20.90
Cost per kg weight gain (N)	120.68	104.45	124.89	114.68	10.87
Total cost of Production (N)	150.86	130.57	156.11	143.35	13.58
Price per kg Pork (N)	250.00	250.00	250.00	250.00	-
Gross margin (N)	99.14	119.43	93.89	106.65	13.58

a-c Means in a row with different superscripts are significantly different (P<0.05). SEM = Standard error of Mean. T1, T2, T3 and T4 = 0, 30%PKM+40%BDG, 35%PKM+35%BDG and 40%PKM+30% BDG diets, respectively. $1.00 = N140.00. N = Naira. PKM = Palm kernel meal; BDG = Brewers dried grain.

Table 7: Carcass Quality and Organ characteristics of Pigs fed diets of different Proportions of PKM and BDG diets

Parameters	T1	T2	T3	T4	SEM
Dressed Weight (%)	57.54	54.33	53.86	51.9	0.96
Ham (%)	36.23	35.95	36.11	36.52	0.51
Shoulder (%)	36.87[b]	37.89[b]	37.63[b]	39.43[a]	0.43
Loin (%)	7.73[a]	6.87[ab]	5.98[b]	6.91[ab]	0.41
Rib cage region (%)	20.62	19.88	21.03	18.21	0.92
Head (%)	17.10[b]	18.25[ab]	19.35[ab]	20.59[a]	0.64
Trotters (%)	4.16	4.29	3.89	4.31	0.46
Tail (%)	0.49	0.64	0.52	0.58	0.4
Back fat thickness					
1st Rib (cm)	1.83	1.5	1.25	1.33	0.2
4th Rib (cm)	1.33	1.25	1.25	0.83	0.16
Abdominal fat thickness (cm)	1	1	1	1	0.12
Carcass length (cm)	84.78[a]	79.00[ab]	81.50[ab]	76.00[b]	1.94
Heart (%)	0.70[b]	1.05[a]	1.04[a]	1.24[a]	0.33
Liver (%)	3.88[b]	5.07[a]	4.67[ab]	5.40[a]	0.48
Lungs (%)	1.65[b]	2.09[ab]	2.07[ab]	2.50[a]	0.46
Kidney (%)	0.34[b]	0.52[a]	0.52[a]	0.58[a]	0.1
Spleen (%)	0.21	0.26	0.26	0.29	0.19
Empty Stomach (%)	1.74	1.83	2.34	2.47	0.54
Small Intestine (%)	4.01	4.8	5.07	5.65	0.51
Large Intestine (%)	3.02	2.58	2.24	3.01	0.27

a, b Means in a row with different superscripts are significantly different (P<0.05). SEM = Standard Error of mean. T1, T2, T3 and T4 = 0, 30%PKM+40%BDG, 35%PKM+35%BDG and 40%PKM+30% BDG diets, respectively. PKM = Palm kernel meal; BDG = Brewers dried grain.

The organ characteristics were also of similar pattern to the carcass quality. Pigs fed the control diet had significantly (P<0.05) lower percent heart, kidney and significantly higher large intestinal weight than those fed different proportions of PKM and BDG diets. The differences in organ percentages could be due to differences in live weight, especially as the pigs had not attained maximum growth before they were slaughtered for carcass and organ quality evaluation. There were no significant differences (P>0.05) among the pigs fed different proportions of PKM and BDG diets in all the organ characteristics evaluated, pointing out that irrespective of the proportions in which the two industrial by-products are included, the organs would not be affected. Generally, the microbial population in the hind gut of pigs has the ability to ferment the high fibre diets of PKM+BDG (Holness, 1991); thereby reducing the effect that such diets could have had on the internal organs of the pigs.

Conclusion: Weaner pigs could be fed diets consisting of 70% PKM and BDG at any of the (30 + 40, 35 + 35, 40 + 30% PKM + BDG, respectively) proportions, with an expectation of inferior FCR and PER, reduced cost of production and increased financial benefit. At the grower stage, 30% PKM + 40% BDG could be fed to pigs to minimize adverse effect on growth performance, and without any adverse effect on carcass quality and organ characteristics.

Acknowledgement

This study was supported by Michael Okpara University of Agriculture, Umudike Senate Research Grant. We also highly appreciate the hard work and dedication of Mr. Friday Eluwa, Chidi Onwuchuruba, Levi Ohaeri and Victor Ukaonu throughout the period of the study.

References

Agricultural Research Council, 1981. The Nutrient Requirements of Pigs: Technical Review ed. Slough, England. Commonwealth Agricultural Bureax, 22: 307.

Akinfala, E. O. and O. O. Tewe, 2002. Utilization of varying levels of palm kernel cake and cassava peels by growing pigs. Tropical Anim. Prod. Invest., 5: 87-93.

Amaefule, K.U., O.C. Onwudike, S.N. Ibe and S.F. Abasiekong, 2006a. Performance, cost benefit, carcass quality and organ characteristics of pigs fed high graded levels of brewers' dried grain diets in the humid tropics. Pak. J. Nutr., 5: 242-247.

Amaefule, K.U., S.O. Okechukwu, S.N. Ukachukwu, F.C. Okoye and O.C. Onwudike, 2006b. Digestibility and nutrient utilization of pigs fed graded levels of brewers' dried grain based diets. Livestock Research for Rural Development (LRRD) Vol. 17, Art. #5 Retrieved February 9 2006, from http://www.cipav.org.co/lrrd18/1/amae 18005.htm

A.O.A.C., 1990. Official methods of Analysis. Association of Official Analytical Chemists, Washington DC, USA.

Depres, E., M. Naves, F. Tamisier, A. Xande and D. Rinaldo, 1994. Growth performance and meat quality of large white and local pigs reared in the tropics. Livestock Research for Rural Development (LRRD) Vol. 6, #2 retrieved April 15, 2006 from LRRD: http://www.cipav. org.co/cipav/gen/index.htm.

Duncan, D.B., 1955. Multiple Range and Multiple F-Tests. Biometrics, 11: 1-42.

Ekenyem, B.U., 2002. The growth responses of weaner pigs fed varying levels of palm kernel cake. Proceedings 27th Annual Conf., Nig. Society for Anim. Prod. (NSAP), March 17-21, Fed. Univ. of Technol. Akure, Nigeria, 156-159.

Gonzalez, C., I. Diaz, M. Leon, B.A. Vecchionacce and J. Ly, 2002. Growth performance and carcass traits in pigs fed sweet potato (*Ipomoea batatas* [Lam] L.) root meal. LRRD: http://www.cipav.org.co /lrrd14/ 6/ gonz146.htm.

Holness, D.H., 1991. Pigs: The Tropical Agriculturists. CTA/ Macmillan Educational Ltd., London.

Jegede, J.O., T.S.B. Tegbe, A.O. Aduku and S.A.S. Olorunju, 1994. The effect of feeding PKM in performance and carcass characteristics of pig. Nig. J. Anim. Prod., 21: 88-95.

Kass, M.L., P.J. Van Soest and W.G. Pond, 1980. Utilization of dietary fibre from alfalfa by growing swine II. Volatile fatty acid concentration in and disappearance from the gastrointestinal tract. J. Anim. Sci., 50: 192-197.

Kennelly, J.J. and F.X. Aherne, 1980. The effect of fibre addition to diets formulated to contain different levels of energy and protein on growth and carcass quality of swine. Can. J. Anim. Sci., 60: 385-393.

Kennelly, J.J., F.X. Aherne and A.J. Lewis, 1978. The effects of levels of isolation or varietal differences in high fibre hull fraction of low glucosinlate rapeseed meals on rat and pigs performance. Can. J. Anim. Sci., 58: 743-752.

Kennelly, J.J., F.X. Aherne and W.C. Sauer, 1981. Volatile fatty acid production in hind gut of swine. Can. J. Anim. Sci., 61: 349-361.

Kwari, L.D., J.U. Igwebuike and M.V. Kwada, 1999. Effect of replacing maize with spent sorghum grain on performance of laying hens. J. Sustain. Agri. and Environ., 1: 25-31.

Litten, J.C., A.M. Corson, A.D. Hall and L. Clarke, 2004. The relationship between growth performance, feed intake, endocrine profile and carcass quality of different maternal and paternal lines of pigs. Livest. Prod. Sci., 89: 35-39.

Low, A.G., 1985. The role of dietary fibre in digestion, absorption and metabolism. Proc. 3rd Inter. Seminar on Digestibilit Physiology in the Pig. Report No. 580. Copenhgen, Denmark: Beret, Statena, Husdyrbugsfors.

McDonald, P.E., R.A. Edward and J.F.D. Greenhalgh, 1995. Animal Nutrition (4th ed).

National Research Council, 1998. Nutrient Requirements of Swine (10th Rev. Ed.). National Academy Press, Washington DC, USA.

Obioha, F.C. and P.C. Anikwe, 1982. Utilization of ensiled and sun dried cassava peels by growing swine. Nutr. Reports Inter., 26: 961-972.

Olomu, J.M., 1995. Monogastric Animal Nutrition: Principles and Practice. Jachem Publ. Benin, Nigeria.

Oluponna, J.A., J.A. Abodunwa, O.O. Adejinmi, F.O. Ogunleke, J.B. Fapohunda and Olubodun, 2002. Performance of rabbits fed brewers' dried grain from different sources. Proceedings 27th Annual Conf., Nig. Society for Anim. Prod. (NSAP), March 17-21, Fed. Univ. of Technol. Akure, Nigeria, pp: 239-241.

Stahly, T.S., 1984. Use of fats in diets for growing pigs. In: Wiseman, J. (Ed.), Fats in Animal Nutrition. Butterworth, London, pp: 313-331.

Steel, R.G.D. and J.H. Torrie, 1980. Priciples and procedures of Statistics. 2nd Ed. McGraw Hill Book Co. Inc. New York, USA.