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Utilization of Palm Kernel Cake as a Replacement for Maize in Diets of Growing Pigs: Effects on Performance, Serum Metabolites, Nutrient Digestibility and Cost of Feed Conversion

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Abstract

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A feeding trial was conducted using 36 growing Largewhite x Landrace pigs with initial live weight of 36.50±1.38 kg to determine the effect of replacing maize with palm kernel cake (PKC) on the performance and economy of production of growing pigs. The product (PKC) was included in the diets at the level of 50% and 100% to replace maize weight for weight (in the control diet containing 30 kg maize). The results obtained with the performance characteristics of the growing pigs during the 42-day experimental period showed no significant ($P>0.05$) difference among treatments. The average daily feed intake, daily weight gain, efficiencies of feed and protein utilization were comparable across the treatment groups. The cost of feed conversion, in terms of cost of feed consumed/day and the feed cost/kg live weight gain of the pigs decreased ($P<0.05$) with increasing levels of PKC in the diets. The apparent digestibility of the nutrients contained in the diets and serum metabolites of the growing pigs were not significantly ($P>0.05$) influenced by the replacement levels of the PKC. It can thus be inferred that PKC can effectively and efficiently replace maize, weight for weight, in diets of growing pigs as an energy source, even up to the total replacement of the maize fraction (30 kg/100 kg of diet) without depressing the performance of the growing pigs and the efficient utilization of the diet.

Key words: Growing pigs, palm kernel cake, performance, feed utilization, cost of feeding

Introduction

Maize is a major energy source in livestock feeds. Like other cereals, it is in short supply, leading to very high prices at certain periods of the year (Rhule, 1999). Increasing costs of conventional feedstuffs such as maize, resulting in inadequate pro-

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vision of feed is a major constraint to pig production in Nigeria. The problem of increasing the scope of animal production to provide the much-needed animal protein has become pronounced in the face of the ever-increasing human population. To reduce the cost of feeding this species of livestock, which competes directly with human beings for the same feedstuffs, attempts have been made to use alternative sources of protein and energy. These have mostly been of agro-industrial by-product origin which is not directly utilizable by man. Palm kernel cake (PKC) is a by-product of oil extraction from palm nut and it is abundant in the tropical areas of the world (Rhule, 1996). It had hitherto been reported to be used as a filler to increase the bulkiness of feed while providing some protein, energy, minerals and vitamins (Alimon and Hair-Bejo, 1995).

Palm kernel cake (a by-product of Oil Palm - *Elaeis guineansis*) has since become an important feed ingredient, with its world production figure in 1993 put at 3.63 million tonnes, out of which 3.57 million tonnes was reported to be used as animal feedstuff (Dutch Commodities Board for Animal Feddstuffs, 1993). In recent times however, there has been an increase in the number of cottage oil palm processing industries in Nigeria due to ban on the importation of vegetable oil which has resulted in abundant availability of PKC. The PKC so obtained varies considerably in chemical composition (protein, fibre or lipids), depending on source (Rhule, 1996), the extent and methodology of oil removal and the proportion of endocarp remaining (Hindle et al., 1995). Despite earlier reports of its high fibre content, low palatability and low availability of amino acids and energy (Hutagalung et al., 1982; McDonald et al., 1988; Duran et al., 1990), various attempts have since been made in respect of its feeding potential to different classes of pigs (Tegbe et al., 1995; Rhule, 1996). Based on average daily gain, feed conversion ratio and carcass measurements, Rhule (1996) recommended 200g kg $^{-1}$ PKC in diets of growing pigs and 300 g kg $^{-1}$ for finishing pigs. In view of severe constraint of high cost of feeding conventional energy feedstuff (maize) to pigs presently, it was therefore the aim of this study to determine the influence of total replacement of the 300 g kg $^{-1}$ maize content in the diet of growing pigs with palm kernel cake (PKC) as energy source on the performance and cost of feed conversion.

Materials and Methods

Animals

Thirty six Large White x Landrace growing pigs of average initial live weight of 36.50±1.38 kg were assigned to three treatments in a completely randomized design with 12 pigs per treatment. There were 3 pigs per pen, representing a replicate and 4 of such pens were allotted to each treatment.

Diets

There were three dietary treatment groups containing 0, 15 and 30 kg PKC/ 100 kg diet (Table 1) representing 0, 50 and 100% replacement of the 30 kg maize content in the control diet. The PKC used was obtained from commercial oil mill within Ibadan metropolis. The diets were neither isonitrogenous nor isocaloric as the replacement was made on weight for weight basis. The pigs were allowed access to feed and water *ad libitum*.

Management

The pigs were weighed individually at the start of the trial and thereafter, weekly

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

Ingredients	0% PKC	50% PKC	100% PKC
Maize	30	15	0
Palm kernel cake	0	15	30
Cassava meal	15	15	15
Groundnut cake	14	14	14
Wheat Bran	25	25	25
Maize offal	10	10	10
DiCal PO_4	2.25	2.25	2.25
Fish meal	3	3	3
Salt	0.5	0.5	0.5
Vit-Min Premix*	0.25	0.25	0.25
Total	100	100	100
Calculated :			
Crude protein, %	16.44	17.64	18.84
Crude fibre, %	4.65	7.2	9.75
Ether extract, %	3.16	4.26	4.71
ME, kcal ME/kg	3382	3307	3278
Determined :			
Crude protein, %	17.75	19.33	19.6
Crude fibre, %	4.32	6.93	7.67
Ether extract, %	4.7	5.31	5.61

*Vit A 10,000,000IU; Vit D3 2,000,000IU; Vit E8,000IU; Vit K 2,000,mg; Vit B1 2,000mg; Vit B2 5,500mg; Vit B6 1,2000mg; Vit B12 12 mg; Biotin 30mg; Folic Acid 600mg; Niacin 10,000mg; Pantothenic Acid 7,000mg; Choline Chloride 500, mg; Vit 10,000mg; Iron

for the 42-day study period. The pigs were housed in concrete floored pens with concrete water and feeding troughs.

Blood Analyses

Six (three males and three females) of the twelve experimental grower pigs in each of the three dietary treatments were randomly selected and bled at the end of the feeding trial. The bleeding was done in the morning before feeding and 10ml of the blood was obtained from the jugular vein into a sample bottle using a sterilized needle and syringe as described by Fanimo (1991). The samples were allowed to clot before centrifuging to obtain the serum used in the determination of some serum metabolites as described by Toro and Ackermann (1975) and Kaneko (1989).

Digestibility Studies

Three males in each of the three dietary treatment groups were used in a digestion trial in a completely randomized

design. The pigs were housed individually in metabolism cages for a five-day adjustment period and four-day total collection of faeces. The faeces were collected and 10% of daily collections were frozen. At the end of the digestibility trial, all faeces were pooled and analyzed for dry matter and proximate compositions. Apparent digestibility of the nutrients was determined for the pigs.

Chemical Analyses

The test ingredient, feed and fecal samples were analyzed for the proximate compositions using the Association of Official Analytical Chemist (A. O. A. C., 1990) recommended procedures. The metabolisable energies were also determined with the equation predicted by Morgan *et al.* (1975). The proximate components and metabolisable energy of the diets are shown on Table1.

Statistical Analysis

All the data obtained were subjected to analysis of variance and where statistical significance were observed, the means were compared using the Duncan's Multiple Range (DMR) test (Steel and Torrie, 1980). The SAS Computer software package (1988) was used for all statistical analyses.

Results and Discussion

Chemical Composition

The chemical composition of the experimental growing pig diets and PKC used in this study are as shown on Tables 1 and 2 respectively. The PKC was observed to contain similar protein and ash contents compared to that used by Rhule (1996). However, the values obtained for the fibre and ether extract contents were double and half respectively compared to the values reported by the same author. The shell content of the PKC sample, which could be as high as 10% has been, reported (Alimon and Hair-Bejo, 1995) to contribute a great deal to the high fibre content of PKC. The fat content is however, a function of the oil extraction method used (Wong and Zahari, 1997). The crude protein, fibre and ether extract contents of the diets increased with increasing levels of PKC as replacement for maize in the diets. The calculated metabolizable energy values of the diets had an inverse relationship with the increasing levels of PKC. The observed decrease in energy contents as the PKC level incre-ased was in agreement with the findings of Longe and Fagbenro-Byron (1990) who reported inverse relationship between energy values of feedstuffs and the fibre contents.

Performance Characteristics

The summary of the performance characteristics as affected by the varying levels of PKC is shown in Table 3. The feed and protein intakes were not significantly ($P>0.05$) affected by the increasing levels of PKC replacement in the diets. The slight numerical increases observed could not be attributed to the influence of the PKC inclusions. The daily weight gain, protein efficiency and feed conversion

Table 2
Chemical composition (%) and metabolisable energy of palm kernel cake (PKC)

Moisture	7
Crude Protein	14.71
Crude Fibre	6.02
Ether Extract	19.5
Ash	3.06
Metabolisable Energy (Kcal ME/kg)	3019

(feed: gain) ratios were equally not significantly affected (P>0.05) by the inclusion of PKC (Table 4).

A decreasing trend in the lysine content resulting in reduced availability of amino acids with increasing level of PKC in the diet was expected, as reported by Rhule (1996). However, from the result of gains recorded in this study, the levels of the lysine and amino acid (AA) availability could be considered adequate since the gains of pigs on the PKC diets was comparable to the control. Lysine is the first limiting AA in pig feeding, and it often has to be supplemented to feed (Ziggers, 2000). The fact that comparable ADG was recorded for all the pigs despite comparable feed intakes even up to the total replacement of the entire maize content of the basal diet with PKC is sufficient evidence to the fact that the PKC diets equally met the energy requirements of the growing pigs.

The increasing crude fibre levels in the diets, resulting from the inclusion of the PKC was expected to reduce the digestibility leading to low availability of AAs and energy of the diets as had observed by Lekule et al. (1986) and Ugye et al. (1988). However, the comparable efficiencies of feed and protein utilization observed in the present study were in agreement with the suggestion of Rhule (1996) for tropical areas. Also, Tegbe et al. (1995) and Codjo (1995) had observed no adverse effect on dry matter intake, body weight gain, feed

Table 3

Performance of growing pigs fed graded levels of palm kernel cake (PKC)

Parameters	0% PKC	50% PKC	100% PKC	SEM(±)
Average Initial weight, kg	37.08	37.58	34.83	1.38
Average Final weight, kg	59.25	59.92	58	0.77
Average Daily weight gain, kg	0.51	0.5	0.5	0.02
Average Daily feed intake, kg	1.79	1.88	1.95	0.1
Av. Daily crude protein intake, kg	0.31	0.33	0.35	0.01
Feed conversion Ratio, feed:gain	3.56	3.79	4.09	0.21
Protein Efficiency Ratio, PER	1.67	1.57	1.46	0.08

a, b: Means along the same row having different superscripts differ significantly (P<0.05).

Table 4

Economy of production of growing pigs fed graded levels of PKC

Parameters	0% PKC	50% PKC	100% PKC	SEM(±)
Feed cost/kg Diet, ₦	39.22	30.97	22.72	-
Feed cost/Day, ₦	69.42^{a}	54.82^{b}	40.21^{c}	0.64
Feed cost/kg liveweight, ₦	137.18^{a}	112.24^{b}	85.31^{c}	2.17
Reduction, %	0	18.18	37.81	-

abc: Means along the same row having different superscript differ significantly (P<0.05). N130.00 = $ 1.00.

efficiency and feed to gain ratio as a result of the addition of PKC to the diets of growing pigs.

Despite the fact that the crude protein content of the 30% PKC diet was relatively the highest, the result showed that there was no significant difference among the three dietary treatment groups, though slight numerical differences was observed. This was a function of the protein contents of the diets. The effective utilization of this agro-industrial by-product in the diet of growing pigs resulted in the comparative efficiencies of utilization of the feed vis-à-vis the protein.

Serum Metabolites

The effect of replacing maize with PKC on the serum metabolites of growing pigs is as shown on Table 5. The serum total protein and albumin of the pigs observed in this study were not significantly (P>0.05) affected by the increasing levels of PKC. These parameters are indicators of protein reserves in animals and can be specifically influenced by dietay protein shortages indicated by alterations in the albumin content (Gouache et al, 1991, Adesehinwa and Ogunmodede, 2002). This result showed that the protein levels in the diets were able to support normal protein reserves in the pigs resulting from efficient protein utilization. Fibrous portions of feed have been reported to influence digestibility of other constituents by exerting a protective action, encasing these constituents in a digestion-proof shield (Adesehinwa and Ogunmodede, 2002). However, this could not have been the case in this study, as comparable values were observed between the maize-control and the PKC diets.

Serum creatinine and urea levels in animals are indicative of muscular wastage (Fashina, 1991; Adesehinwa and Ogunmodede, 2002). The values observed were fairly constant and comparable across the groups, as such; the animals could not have suffered muscular wastage but an efficient utilization of the diets, thereby resulting in high tissue deposition (Adesehinwa, 2004) across the groups. It was also evident from the serum cholesterol values observed in this study that it was not significantly (P>0.05) influenced by the varying PKC levels, in spite of the numerical increases observed with the dietary fat contents of the diets. This was in contrast to earlier findings by Adesehinwa and Ogunmodede (2002) who reported serum cholesterol levels to be influenced by dietary fat.

Reduction in blood glucose as a result

Table 5

Serum Metabolites of growing pigs fed diets containing PKC

Parameters	0% PKC	50% PKC	100% PKC	SEM (±)
Total Protein, g/dl	6.52	6.58	6.6	0.17
Albumin, g/dl	3.6	3.85	3.86	0.15
Creatinine, mg/dl	1.52	1.57	1.64	0.12
Urea, mg/dl	58.5	60.7	62.5	2.33
Cholesterol, mg/dl	120.5	124.31	127.94	3.05
Glucose, mg/dl	122.94	114.56	111.25	5.14

a, b: Means along the same row having different superscripts differ significantly (P<0.05).

of high fibre diets had earlier been noted (Dodson *et al,* 1981) contrary to the result of the present study, despite the high fibrous nature of the test ingredient (PKC). The level of the fibrous feedstuff used in pig diets varies with the proportion of the cell wall constituents and decreased growth efficiency has been reported in pigs with cell wall content >25% (Longe and Fagbenro-Byron, 1990). It could therefore be inferred that the cell wall content of the PKC used may be lower than 25% hence the comparable result to the maize-based control. Stahly and Cromwell (1986) has reported the digestibility of Neutral Detergent Fibre (NDF) to be optimized in pigs fed diets containing 15% or less NDF.

Nutrient Digestibility

The daily feed intake (DFI) of the pigs were not significantly (P>0.05) affected by the PKC replacement levels, even up to the total replacement of the maize content of the basal diet. Even when the energy content of the diets was expected to be lowered as a result of the fibrous test ingredient (PKC), this seemed not to be sufficient to result in excessive bulk nor reduced palatability. Adesehinwa (1997) had reported this to occur only when the dietary crude fibre exceed 10-15% of the diet.

The apparent digestibility of the dry matter (DM) and the nutrients contained in the diets were not significantly (P>0.05) affected by the PKC (Table 6). Though the replacement levels of the PKC brought about slight numerical increase in the crude fibre content of the diets, the levels might not be sufficient to result in variations in the apparent digestibility (Just, 1979). The comparable digestibility observed therefore could be attributed to the ability of the resultant fibre being able to aid digestion (Adesehinwa, 1997), hence reduction in the overall retention time of the digests in the gastrointestinal tract (GIT) (Stanogias and Pearce, 1985a and b). A feature of most locally available agro-industrial by-products and waste is fibrousness and this has been reported to limit their utilization (Longe and Fagbenro-Byron). However, pigs are known to be capable of degrading fibre through microbial fermentation in the lower part of the GIT. The product of this activity are volatile fatty acids which contribute significantly (up to 30%) to the

Table 6

Effect of replacement of maize with PKC on nutrient digestibility of pigs

Parameters	0% PKC	50% PKC	100% PKC	SEM (±)
Daily Feed Intake, kg	1.79	1.88	1.95	0.1
Apparent Digestib., %				
Dry Matter	75.33	75.2	73.77	2.08
Crude Protein	73.26	75.49	78.85	3.57
Crude Fibre	75.31	73.75	70.73	3.69
Ether Extract	80.75	83.75	87.74	2.95
Ash	64.25	65.4	68.67	3.86
Nitrogen Free Extract	70.85	71.48	75.63	4.33

a, b: Means along the same row having different superscripts differ significantly (P<0.05).

net energy requirement of the pig (Ehle et al., 1982; Rerat et al., 1987). Fibre utilization is influenced by the physical and chemical composition of the total diet (Myer et al, 1975).The efficient utilization of the crude fibre contained in the diets used in the study could explain the comparable nutrient digestibilities recorded.

Economy of Production

The result of the economy of production expressed in terms of the costs of feed consumed per day and per kilogram live weight gain are as shown in Table 4. The cost of feed consumed per day in Naira decreased ($P<0.05$) with increasing replacement of maize with PKC. The cost incurred/day feeding the 100% PKC diet was significantly lower than the 50% PKC diet. Despite the comparable dry matter intake observed with all the pigs on all the diets, the cost of feed consumed/day was higher ($P<0.05$) for the maize based-control diet. This could be attributed to the high cost of the maize (#30.00/kg), which was three times the cost of the PKC used (#10.00/kg), in agreement with earlier report that PKC is a relatively cheaper feedstuff (Adesehinwa et al., 1998).

The diets containing PKC were more cost effective ($P<0.05$) than the maize-control diets in terms of the cost of feed/kg live weight gain based on the fact that palm kernel cake is relatively cheaper than maize as observed in the resultant higher cost of feed per day ($P<0.05$). Even when the cheapest feed consumed/day was observed with the 100% PKC diet, the result obtained in terms of the cost of feed per kg live weight gain was comparable to that of pigs on the 50% PKC diet. However, the relatively cheaper diets brought about higher feed conversion efficiency, resulting in the least cost of producing one kilograms live weight gain. This agreed with the findings of Phillips (1984) who reported that reducing feed cost was not only to obtain cheaper feed but that it was also dependent on the production result obtained with this cheaper feed.

It can therefore be concluded from these results that the 100% PKC diet, containing 30 kg PKC/100 kg diet was the most the most efficient in terms of the economy of feed conversion, bringing about gains comparable to those of pigs fed the maize-based control and 50% PKC replacement diets, at the cheapest cost. The feeding costs of growing pigs can thus be reduced and the profit margin increased with the replacement of the maize content with palm kernel cake, a relatively cheaper energy feedstuff, in diets of growing pigs. Zahari and Alimon (2006) had earlier reported improvement in feed efficiency through accelerated use of local feedstuffs to represent a potential area of application to reduce high cost in livestock feeding. They reported PKC as a high energy source and cost-effective ingredient for ration formulation.

Conclusion

The increase in the number of cottage oil palm processing industries in Nigeria due to the ban on importation of vegetable oil has resulted in the abundant availability of PKC in recent times. PKC has therefore been further shown from this study as a potential energy source and a cost effective ingredient in the formulation of compound feed for growing pigs. The increased use of this local feedstuff (PKC) with improved efficiency of utilization represent a potential means of cutting down on the cost of feeding growing pigs.

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