REPLACEMENT VALUE OF MAIZE OFFAL FOR MAIZE IN THE DIET OF WEANER PIGS CONTAINING CHICKEN OFFAL MEAL

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ABSTRACT

Thirty six Largewhite x Landrace weaner pigs, between 49-56 days of age, averaging 8.84 ± 0.32 kg body weight were used in a 56-day trial to determine the replacement value of maize offal (MO) for maize in the diet of weaner pigs containing chicken offal meal (COM). The pigs were randomly allotted to six dietary treatment groups of 0, 25, 30, 35, 40 and 45% MO replacement for maize (0, 13.66, 16.34, 19.03, 21.70 and 24.39% MO inclusion respectively) in isonitrogenous (20% crude protein) diets enriched with COM. The MO inclusions in the diets was directly related to the crude fibre and inversely related to the metabolisable energy contents numerically. The dry matter and protein intakes (0.80 - 0.87kg and 0.16 - 0.18kg respectively) were not affected ($P > 0.05$) by increasing MO inclusions, thereby resulting in the efficient utilization of the constituent nutrients in terms of feed : gain, protein efficiency ratio and metabolisable energy per gain to support comparable ($P > 0.05$) gains across the groups. The feed cost per liveweight gain was not significantly ($P > 0.05$) affected by the increasing MO inclusion up to 24.39% (i.e. 45% maize replacement). The serum metabolites (total protein, albumin, globulin, creatinine, urea, cholesterol and glucose values) of the pigs confirmed the satisfactory efficient utilization of the nutrients as well as the overall feed. It can therefore be inferred from the results that weaner pigs can tolerate up to 24.39% maize offal inclusion as a replacement for maize (45% replacement) in diet enriched

with chicken offal meal.

Keywords: Replacement value, Maize offal, Weaner pigs, Chicken offal meal

INTRODUCTION

The proportion of cereal grains and animal products that can be fed to pigs for conversion to meat can be expected to decline with the increasing world human population (Adesehinwa and Okunlola, 2000). This is as a result of direct competition with man for these feeds as sources of energy and protein (Pond and Maner, 1974). However, since the economics of swine feeding are largely dependent on local conditions of feedstuff availability and competition for the same foodstuff by either humans or other animals, there is therefore the need to utilize unused resources to feed animals in the face of scarcity and high price.

These include the large quantities of by-products hitherto regarded as wastes but which can be valuable for swine feeding purposes as energy and protein sources. The results of previous trials (Adesehinwa *et al.*, 1999 a, b, c) on weaner pigs have shown maize offal and chicken offal meal as such alternatives. Weaner pigs were found to tolerate up to 25% maize offal replacement of the metabolizable energy contribution of maize in diets (13.66% maize offal inclusion) with or without animal protein supplementation, but not 50% (Adesehinwa *et al.*, 1999 a, b, c). The inclusion of chicken offal meal has been found to enhance performance than did blood meal

as a protein supplement in weaner pig diets, in 1999c). The weaner diet is the most critical in terms of economic production of pig meat (Ogunfowora *et al.*, 1980). Hence, even when the animals could not tolerate up to 50% maize offal level with animal protein inclusion (Adeschinwa *et al.*, 1999c), it was necessary to investigate the point at which the change took place between the 25 and 50% maize offal levels.

It was therefore the aim of this study to determine the optimum replacement level of maize offal for maize in the ration of weaner pigs containing chicken offal meal as animal protein supplement.

MATERIALS AND METHODS

Experimental Diets

There were six dietary treatments in the study. These include the 0% maize offal (Maize-based) control and the replacement of maize with maize offal at 25, 30, 35, 40 and 45% levels. The isonitrogenous diets were formulated to contain 20% crude protein, with 20% of the crude protein supplied by soyabean

a previous experiment (Adeschinwa *et al.*, cake into the diet replaced with chicken offal meal. The percentage composition of the experimental diets are as shown in Table 1.

Experimental Animals

Thirty six Large White x Landrace weaner pigs, between 49-56 days of age averaging 8.84 ± 0.32 kg body weight were used in the 56-day growth assay to evaluate maize offal as a replacement for maize in the diet of weaner pigs containing chicken offal meal. The pigs were injected with Ivomec(R) (Ivermectin) against endo- and ecto-parasites (1ml/50kg liveweight) subcutaneously. They were randomly allocated to the six treatment groups based on bodyweight, sex and litter origin in a completely randomized design.

Each group of six pigs consisted three replicates of a male and a female, penned together. All the pigs were housed on concrete floored pens equipped with feeding and watering troughs to allow *ad libitum*

TABLE 1: GROSS COMPOSITION (%) OF WEANER PIG DIETS CONTAINING COM WITH GRADED LEVELS OF MAIZE OFFAL

Ingredient	Levels of Maize Offal			Replacement of maize (%)		
	0	25	30	35	40	45
Maize	53.34	39.94	37.32	34.69	32.07	29.45
Maize Offal	0.00	13.66	16.34	19.03	21.70	24.39
Soybean Cake	23.20	23.20	23.20	23.20	23.20	23.20
Chicken Offal Meal	3.71	3.45	3.39	3.33	3.28	3.21
Palm Kernel Cake	10.00	10.00	10.00	10.00	10.00	10.00
Brewers Dried Grain	5.00	5.00	5.00	5.00	5.00	5.00
Bone Meal	3.00	3.00	3.00	3.00	3.00	3.00
Oyster Shell	1.00	1.00	1.00	1.00	1.00	1.00
Premix (Vit-Min)*	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.50	0.50	0.50	0.50	0.50	0.50
Total	100.0	100.0	100.0	100.0	100.0	100.0

*Contents per kg: Vit A 10,000,000 IU; Vit D₃ 2,000,000 IU; Vit E, 8,000 IU; Vit K, 2,000 mg; Vit B₁, 2,000 mg; Vit B₂, 5,500 mg; Vit B₆, 1,200 mg; Vit B₁₂, 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, 8,000 mg; Zn, 50,000 mg; Iodine, 2,000mg; Cobalt, 450 mg; Selenium, 100 mg; Mg, 100,000 mg; Anti Oxidant, 6,000 mg.

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consumption of feed and water, respectively. The pigs were weighed weekly and the weekly feed consumption was also recorded. These records were used to monitor and assess the weight gain, dry matter intake, protein intake, feed : gain ratio, protein efficiency ratio, metabolisable energy intake per day and the metabolisable energy intake per kg gain.

The cost of feed/kg diet, feed consumed/day and feed/kg liveweight gained were also calculated and recorded.

Chemical Analyses

The feed samples were analyzed for the proximate components using the methods of the Association of Official Analytical Chemists (A.O.A.C., 1990). The metabolisable energy values were also determined with the equation predicted by Morgan *et al.* (1975), based on the proximate components.

$$ME = 0.416CP + 0.605EE + 0.367NFE - 20.06$$

where ME = Metabolisable Energy; CP = Crude Protein;

EE = Ether Extract; NFE = Nitrogen Free Extract

Blood Analyses

Four (two males and two females) of the six experimental weaner pigs in each of the six dietary treatment groups were randomly selected and bled at the end of the feeding trial. The animals were given only water on the evening preceding the bleeding. 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.

The samples were allowed to clot before centrifuging to obtain the serum. The separated sera were decanted into bijoux bottles and stored at -10°C until analyzed. The determination of the serum metabolites was carried out as described by Toro and Ackermann (1975) and Kaneko (1989).

Statistical Analyses

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 Test. The regression analyses of the performance characteristics (X) as dependent variables on the daily weight gain (Y) as independent variable by treatment were also carried out. The SAS Computer software package (1988) was used for all statistical analyses.

RESULTS

Chemical Composition

The chemical composition of the diets and test ingredients employed in the trial are presented in Table 2. The crude protein contents of the diets were generally slightly higher than the calculated value of 20%. The crude fibre contents increased numerically with increasing MO inclusion, with the values ranging from 5.83% for the maize-based control diet to 7.38% for the 45% MO replacement diet. The ether extract and ash contents of the diets were unaffected by the varying levels of MO inclusions. The predicted metabolisable energy values of the diets were inversely related to the MO levels, indicating dilution of the energy contents with increasing inclusions.

Performance Characteristics

The performance indices of the weaner pigs fed graded levels of maize offal in diets enriched with chicken offal meal (COM) are summarized in Table 3. The daily dry matter and protein intake of the pigs were not significantly ($P > 0.05$) affected by the levels of MO inclusions. This was also reflected in the mean daily weight gain, feed : gain ratio (FCR) and protein efficiency ratio (PER), as no significant difference ($P > 0.05$) was observed. The metabolisable energy intake per day of the animals and their metabolisable energy intake per gain were also unaffected ($P > 0.05$) by the varying MO levels. Hence, the observed statistical similarity in the values.

TABLE 2: ENERGY (kcal) AND PROXIMATE COMPOSITION (% DM) OF WEANER DIETS AND TEST INGREDIENTS

	0	25	30	35	40	50	MO	COM
Dry matter	90.16	90.11	90.16	90.00	89.90	90.08	89.70	90.64
CP	20.50	20.56	20.45	20.90	20.80	20.34	10.15	59.09
Crude Fibre	5.83	6.57	6.83	7.05	7.27	7.38	9.20	4.64
CF	8.53	8.69	8.78	8.64	8.77	8.88	2.60	14.36
Ash	7.37	7.56	7.48	7.59	7.51	7.84	1.50	7.50
NFE	57.77	56.62	56.46	55.82	55.65	55.56	76.55	14.41
ME (B)* (Kcal ME/kg)*	3531.01	3459.51	3447.60	3416.08	3410.05	3372.47	3292.86	4404.22

* Estimated employing the prediction equation of Morgan *et al.* (1975); ME = Metabolizable energy

TABLE 3: PERFORMANCE OF WEANER PIGS FED GRADED LEVELS OF MAIZE OFFAL AS REPLACEMENT FOR MAIZE IN DIETS CONTAINING CHICKEN OFFAL MEAL (COM)

Performance Index	Levels of Maize Offal Replacement of Maize (%)					
	0	25	30	35	40	45
Daily Weight Gain (DWG, kg)	0.47±0.222	0.49±0.034	0.48±0.028	0.47±0.043	0.51±0.032	0.48±0.038
Daily DM Intake (DDMI) kg	0.85±0.054	0.84±0.062	0.80±0.046	0.82±0.049	0.87±0.054	0.85±0.057
Daily Protein Intake (DPI, kg)	0.17±0.011	0.17±0.010	0.16±0.009	0.17±0.010	0.18±0.011	0.17±0.012
Feed : Gain Ratio (FCR)	1.80±0.102	1.84±0.153	1.74±0.108	1.87±0.152	1.78±0.115	1.84±0.139
Protein Efficiency Ratio (PER)	2.83±0.163	2.95±0.194	2.99±0.231	2.81±0.251	2.90±0.0238	2.92±0.268
Metabolisable Energy Intake per Day (MEID) KcalME/kg/day	2987.74±189.862	2870.91±213.67	2757.34±156.734	2798.26±168.06	2972.10±184.799	2853.35±195.451
Metabolisable Energy Intake per Gain (MEIG) Kcal/ME/kg	6361.82±361.517	6277.67±529.336	5991.78±371.595	6382.28±520.496	6067.30±393.214	6199.02±469.51

Serum Metabolites

The effect of the graded levels of MO in diets enriched with COM on the serum metabolites of the experimental weaner pigs are presented in Table 4. The varying levels of MO in the weaner diets enriched with COM had no significant ($P > 0.05$) effect on the serum total protein, albumin, globulin, creatinine and urea contents of the pigs.

Economy of Production

The economy of production or cost of feed conversion (Table 5) showed no significant ($P > 0.05$) differences in the cost of feed consumed per day and the feed cost per kilogramme liveweight gain. These similarities were observed despite the gradual numerical decrease in the cost of feed per kilogramme diet as the MO inclusion increased.

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TABLE 4: SOME SERUM METABOLITES OF WEANER PIGS FED GRADED LEVELS OF MAIZE OFFAL AS REPLACEMENT FOR MAIZE IN DIETS CONTAINING CHICKEN OFFAL MEAL

Metabolites	Levels of Maize Offal				Replacement of Maize (%)	
	0	25	30	35	40	45
Total Protein (g/dl)	7.05±0.55	6.60±0.20	6.50±0.10	6.60±0.50	6.70±0.10	6.45±0.35
Albumin (g/dl)	4.00±0.00	4.05±0.05	4.05±0.15	4.00±0.40	4.00±0.00	3.85±0.15
Globulin (g/dl)	3.05±0.55	2.55±0.15	2.45±0.25	2.60±0.10	2.70±0.10	2.60.050
Creatinine (mg/dl)	1.00±0.00	1.00±0.00	1.05±0.05	1.00±0.10	1.05±0.05	1.00±0.10
Urea (mg/dl)	28.00±1.00	26.50±1.50	27.00±3.00	20.50±1.50	23.50±3.50	21.50±4.50
Cholesterol (mg/dl)	119.00±8.00	127.00±2.00	120.00±5.00	124.00±11.00	132.00±7.00	122.50±0.50
Glucose (mg/dl)	57.00±1.00	62.50±6.50	53.00±3.00	59.50±5.00	47.00±3.00	44.00±0.00

TABLE 5: ECONOMY OF PRODUCTION OF WEANER PIGS FED GRADED LEVELS OF MAIZE OFFAL REPLACEMENT FOR MAIZE IN DIETS CONTAINING CHICKEN OFFAL MEAL

Performance Index	Levels of Maize Offal				Replacement of Maize (%)	
	0	25	30	35	40	45
Feed Cost/kg Diet (N)*	7.60	7.18	7.10	7.02	6.94	6.86
Cost of Feed Consumed/day (FCD) (N/Day)	7.13±0.45	6.49±0.39	6.30±0.36	6.39±0.38	6.73±0.42	6.44±0.44
Cost of Feed/kg Liveweight Gain (FCLWG) (N/kg)	15.19±0.86	13.84±0.85	13.69±0.85	14.57±1.19	13.75±0.89	14.00±1.06

* as at 1994

Regression Analysis

The regression equations showing the contributions of dry matter intake, protein intake, feed efficiency, protein efficiency, metabolisable energy (ME) intake per day and ME required per kilograms gain to daily weight gain of the animals on each of the diets are shown in Table 6. In all the diets, none of the performance indices contributed significantly ($P > 0.05$) to the determination of

the daily weight gain except diets containing 25 and 30% MO inclusion. The daily protein intake significantly ($P < 0.01$) contributed positively to the daily weight gain of the animals on the 25% MO inclusion diet. The weight gains of the animals on the 30% MO inclusion diet was significantly ($P < 0.05$) influenced positively by the feed efficiency and negatively by the ME intake per gain.

TABLE 6: LINEAR REGRESSION EQUATIONS OF SOME PERFORMANCE INDICES AS DEPENDENT ON DAILY WEIGHT GAIN (Y) OF THE WEANER PIGS AT EACH LEVEL OF MO INCLUSION WITH COM

Level of M.O. Inclusion (%)	Regression Equations							R ²
0	Y = 0.188 (0.262)	+1.819DDMI (6.354)	-17.704DPI (24.236)	+1.856FCR (5.928)	-0.042PER (0.045)	+0.660MEID (1.849)	-0.569MEIG (1.684)	0.978
25	Y = 0.047 (0.229)	-7.075DDMI (6.617)	+2.096DPI (0.486)	+6.717FCR (5.857)	+0.07PER (0.036)	+2.075MEID (1.917)	-1.97MEIG (1.700)	0.989
30	Y = 0.395 (0.089)	-1.582DDMI (2.778)	-10.314DPI (5.890)	+7.901FCR (2.738)	+0.019PER (0.013)	+1.217MEID (0.625)	-2.355MEIG (0.799)	0.998
35	Y = -0.114 (0.266)	-32.394DDMI (22.227)	+32.061DPI (31.775)	-8.124FCR (15.474)	+0.094PER (0.043)	7.713MEID (5.853)	+2.343MEIG (4.531)	0.977
40	Y = 0.300 (0.212)	+21.253DDMI (10.664)	-14.565DPI (18.938)	-4.097FCR (8.288)	+0.040PER (0.031)	-5.169MEID (3.015)	+1.130MEIG (2.437)	0.985
45	Y = 0.084 (0.224)	-4.894DDMI (24.657)	-17.025DPI (54.147)	-3.428FCR (11.848)	+0.067PER (0.034)	+2.652MEID (4.845)	+0.970MEIG (3.505)	0.968

* P < 0.05; ** P < 0.01; *** P < 0.001

Figures in bracket are standard errors of regression coefficients (Se_b).

DISCUSSION

Chemical Composition

The increasing maize offal (MO) replacement of maize resulted in a corresponding numerical increase in the crude fibre level of the diet, brought about by the fibre content of the MO. It was however observed that the increasing fibre content of the diet resulted in a gradual decrease in the energy contents of the diets as was also obtained in a previous trial.

Performance Characteristics

The daily protein intake of pigs across the groups became a function of the DM intake because the diets were isonitrogenous (20% crude protein). This similarity in the DM and protein intake however resulted in comparable weight gains. This can be attributed to the efficient utilization of the constituent protein and energy. The rate and efficiency of gains have been reported to be closely related to the nutrient intake and utilization (O'Grady and Bowland, 1971; Cooke *et al.*, 1972 and Fctuga *et al.*, 1975a and b).

The COM could be seen to have enhanced the utilization of the diets with the comparable

performance results. Fanimó (1991) had reported better efficiency and improved performance for pigs on diets containing COM. This superior result was similar to those of pigs fed similar proteins at the 0 and 25% levels of MO replacement of maize levels in a previous study but not at the 50% MO replacement (Adesehinwa *et al.*, 1999a, b, c). This result show that the weaner pigs can utilize 45% replacement of maize with MO (24.39%) in their diets enriched with COM.

Serum Metabolites

The serum albumin of the weaner pigs were unaffected by the varying MO inclusion in their diets hence the comparable total protein content obtained across the groups. This is in agreement with the findings of Allison (1955) who reported changes in the protein reserves in animals as indicated by serum total protein to be associated with alterations in the albumin fraction. Changes in albumin content was reported to be influenced by protein shortage (Goauche *et al.*, 1991). The result of this study, which was within the normal range reported by Mirtruka and Rawnsley (1977) showed that the protein level in the diet was

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able to support the normal protein however, it should be noted that the diets were isonitrogenous and the protein intake levels across the groups were comparable (Table 3).

The results of the serum creatinine and urea, which reflect the extent of muscular wastage brought about by the inadequacy of protein (Adeschinwa, 1992) were within the normal range reported by Kaneko (1989). The similarity in the values obtained across the groups could be attributed to the comparable efficient utilization of the protein in the diets as shown by the PER values. The observed similarity in the serum cholesterol values was expected because of the comparable ($P > 0.05$) DM intake of diets containing similar crude fat contents thereby resulting in comparable dietary fat intake. Hutagalung *et al.* (1969) and Jurgens *et al.* (1970) had reported serum cholesterol levels of pigs to be affected by the amount of dietary fat. The similarity in the nutrient contents of the diets (Table 2) could also bring about similarity in the serum cholesterol level, in agreement with the findings of Megibben *et al.* (1967) who reported similar result with pigs allowed different access to the same food. The values observed for the serum glucose in this study were unaffected by the varying MO inclusion up to 45% replacement level.

Economy of Production

The result showed the feed cost per kilogramme diet to decrease with the increasing MO replacement of maize. This could be attributed to the replacement of the more expensive maize with the relatively cheaper MO. Ter Meulen and El-Harith (1985); Longe and Fagbenro-Byron (1990) and Ande (1992) have reported MO as a cheap energy source.

However, despite the increasing MO inclusion, the costs of feed consumed per day across the treatments were comparable. This could be attributed to the comparable DM intake across the treatments (Table 3). The cost of feed per production value (Phillips, 1984) was kg gain

which is a reflection of the real comparable across the treatments indicating the efficient utilization of the diets as shown in Table 3. Ikurior (1993) noted the feed utilization to be closely associated with the real production value of the diets.

Regression Analysis

None of the performance indices considered significantly contributed individually to the daily weight gains of pigs fed diets containing the varying levels of MO inclusion as observed in the previous experiment with COM proteins except for the 25 and 30% MO diets. It could therefore be said that the daily weight gains of the pigs were determined by the collective contributions of all the measured criteria as shown by the high R^2 values. However, the gains of the pigs fed the 25% MO inclusion diet were significantly influenced by the efficient utilization of the energy and the diet as a whole. The dependence of the rate and efficiency of gains were closely related to the nutrient intake and utilization as observed by O'Grady and Bowland (1971); Cooke *et al.* (1972); Fetuga *et al.* (1975a and b).

The regression analysis results, therefore showed that at the 35, 40 and 45% MO inclusion levels, none of the performance characteristics considered was singly a significant ($P > 0.05$) explanatory variable for the weight gain. The lack of strong positive and negative relationships was an indication of the minimum effect of individual measurements on the daily weight gain (Fanimu, 1991).

CONCLUSION

It can therefore be concluded from the results of this study that while the increase in the MO inclusion in the diets resulted in increased crude fibre contents and so a dilution in the ME contents, the dry matter (DM) and protein intake values were not affected. The diets and the constituent nutrients were efficiently utilized in terms of feed : grain, PER, ME intake per gain to support comparable gains.

The performance of pigs on the MO diets up to the 45% replacement of maize were comparable to those obtained with the maize-based control diet. The costs of feed per kg liveweight gain were not significantly affected by the increasing MO inclusion, hence the economy of feed conversion by the pigs on the MO diets (up to 45% replacement of maize) was comparable to those on the maize-based control.

The serum metabolites confirmed the satisfactory efficient utilization of the

constituent protein and energy, as well as the entire feed by the pigs fed the MO diets. The observed values were comparable at all levels of MO and the maize-based control diet. The daily weight gains across the treatments resulted from the collective contributions of all measuring criteria bringing about the effective utilization of up to 24.39% MO in the diets of weaner pigs (45% MO replacement of maize) containing chicken offal meal protein supplement.

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