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Performance and Meat Quality of Growing Pigs Fed Composite Leaf Meal Premix as an Alternative to Commercial Premix

Adegbenro, Muyiwa; Agbede, Johnson Oluwasola; Onibi, Gbenga Emmanuel; Aletor, Valentine Ayobore

Department of Animal Production & Health, The Federal University of Technology, Akure, Nigeria.

Corresponding Author: Adegbenro, M. Department of Animal Production and Health, The Federal University of Technology, Akure, Nigeria. **Email:** madegbenro@futa.edu.ng **Phone**:+234 803 493 5735

Abstract— *This trial was designed to study the effects of using composite leaf meal produced from five (5) different leaves: Cassava, Moringa, fluted pumpkin, African basil and bitter leaves as a premix in the diets of growing pigs. Twenty four large white weaner-pigs were used for this trial comprising six treatments and four replicates with one pig per replicate. Six diets were formulated in which composite leaf meal was fed at 0 (2.5% premix), 10 (2.0% premix), 20 (1.5% premix), 30 (1.0% premix), 40 (0.5% premix) and 50 (0.0% premix) g/kg at the expense of a commercial premix and designated diets I, II, III, IV, V and VI. The pigs were then assigned to these 6 dietary treatments which were fed to the pigs at 5% of their body weight for 8 weeks experimental period. Water was supplied ad libitum throughout the experimental period. All data were subjected to analysis of variance. Results showed that, there was no significant difference (P>0.05) in the final weights of the pigs. Highest final live weight (41.67 ± 0.84 kg) and highest feed intake (75.92 ± 0.06) were recorded in animals fed diet II, while the lowest final live weight (37.67 ± 0.84kg) and lowest feed intake (75.57 ± 0.06) were recorded in animals fed diets V and I, respectively. The eye muscle width of carcass was significantly higher (P<0.05) in pigs fed composite leaf meal diets than those fed the control. The eviscerated weights (kg), head (kg), carcass length (cm) and the relative organs weight of liver, kidney, heart, lungs and spleen (g/kg body weight) were not significantly (P>0.05) influenced by the dietary treatments. The longest carcass length was recorded in animals fed diet VI (73.00 cm), while the shortest length was recorded in animals fed diet III (69.33 cm). For the pH of the meat samples, the highest value (5.77) was recorded in pigs fed diet VI, while the lowest pH (5.74) was recorded in pigs fed diet I. However, there was no significant (P>0.05) treatment effect in the pH values. Generally, the cost of the experimental diets (₦/kg) was least in 50 g/kg composite leaf meal diet (₦55.44/kg) and highest in 0 g/kg composite leaf meal diet (₦60.43/kg) and the percentage cost reduction increased as the level of the composite leaf meal inclusion increased (1.44 – 8.26 %). It could be concluded within the limit of this study, that composite leaf meal had high nutrient potentials for pigs and could completely replace commercial premix in pig diets without any deleterious effect.*

Keywords— Pig production, Composite leaf meal, Premix, Growth, Carcass characteristics, Relative organs weight, Meat pH, Eye muscle.

I. INTRODUCTION

The search for least-cost rations has led to the replacement of expensive feeding-stuff with cheaper alternatives like agricultural by-products and leaf meal in the formulation of pig rations. The increasing competition between man and animals for available grains is one of the factors causing protein intake shortages in developing nations like Nigeria. The resultant sub-optimal consumption of animal protein by a greater percentage of Nigerian population has challenged not only livestock farmers, but also researchers and policy makers (Iheukwumere *et al.*, 2007). The realization that feeding alone currently accounts for over 75 % of intensive non-ruminant (poultry and pig) production in the third world countries, including Nigeria has stimulated research interest aimed at exploiting different locally available alternative feeding resources (Agbede and Aletor, 2003). The need to harness the potentials of the numerous agro-industrial by-products and green vegetable plants as replacements for the more expensive conventional feed ingredients have been variously expressed (Agbede and Aletor 2004; Adegbenro *et al.*, 2012). Leaf meals not only serve as a protein source but also provide some necessary vitamins such as vitamin A and C, minerals and also oxycarotenoids, which causes yellow colour of broiler skin, shank and egg yolk (Abu *et al.*, 2015). Considerable attention has been focused on leaf meals from Cajanus cajan (Damaris, 2007). This study is therefore seeks to evaluate the effect of feeding varying levels of composite leaf meal as a replacement for premix on the performance, carcass and organ characteristics of growing pigs.

II. MATERIALS AND METHODS

Composite Leaf Meal Production: Leaves from five (5) selected plants (Cassava, Moringa, Fluted pumpkin, African basil and Bitter leaves) were "harvest" and air-dried to prevent loss of some vital nutrients. The air-dried leaves were milled using hammer mill and stored in plastic containers prior to use. Thereafter, the leaves were mixed together in the same ratio (1:1:1:1:1) to produce the composite leaf meal.

Experimental Diets and Site: A basal diet was formulated to meet the requirement of swine (NRC, 1994). The quantity of the commercial premix in the basal diet (Diet I) was reduced by 0, 20, 40, 60, 80 and 100 % replaced with 0, 10, 20, 30, 40 and 50 g/kg of composite leaf meal designated Diets I - VI, respectively as presented in Tables 1 and 2. The feeding trial was carried out at the Livestock Section (Piggery Unit) of the Teaching and Research Farm of The Federal University of Technology, Akure, Nigeria.

Experimental Animals and Management: The statistical design of the experiment was a completely randomized design with a total number of twenty four (24) weanling pigs (*Suis* large white) assigned to six (6) dietary treatments, replicated four times with one (1) pig per replicate. The weight of each pig was measured and recorded as initial weight for the animal. Each animal's weight was recorded and later balanced in order to get the average weight for all the treatments. Thereafter, their respective weaners' diets were fed at 5 % of their body weight for the period of four weeks during which the weekly feed consumption and weight changes were measured and feed conversion ratio were calculated. Thereafter, the growers diets were fed to their respective group from the fifth week to the eight weeks at 5 % of their body weight and the same parameters at the weaners' phase were measured.

Slaughtering of Animals: At the end of the feeding trials, all the animals were starved over night and weighed. The animals were hanged suspended upside down on their hind limbs so as to allow for proper bleeding. The animals were then sacrificed through mechanical stunning severance of the jugular vein. Each slaughtered animal was de-haired using cold water, soap and blade and dressed. The animal's lengths were measured after which they were eviscerated and dissected into parts. The following weights were taken; live weight (kg), dressed weight (kg), eviscerated weight (kg), head (kg), liver (g/kg), heart (g/kg), kidney (g/kg), lungs (g/kg) and spleen (g/kg). Also, the following measurements were taken; carcass length (cm), eye muscle (cm), subcutaneous shoulder fat (cm), loin (cm), fat over mid back (cm) and loin side (cm). The head was removed and carcass split longitudinally down the mid line. The length was measured from the anterior edge of the symphysis pubis to the recess of the first rib. Subcutaneous fat depths were measured on each side over the shoulder, mid back and loin. Sides from each carcass were cut across at a point level with the head of the last rib. The maximum width (A) and depth (B) of the exposed *M. longissimus* were measured. The thickness of the subcutaneous fat surrounding the *M. longissimus* was measured at sites P_2 (65 mm from the dorsal mid line), C (over B at right angle to the skin) and K (at the dorso-lateral corner of the *M. longissimus* and at a right angle to the skin) (Gill *et al.*, 1995). The pH of the meat muscles samples was determined using a digital pH meter (DpH-2 ATAGO®). A sharp pointed knife was used to pierce the intact muscles to about 3 – 4cm and the digital pH meter was immediately inserted into the sample muscles to read the pH. The cost of producing the experimental diets were estimated based on prevailing market prices for the ingredients as at the time of the experiment and percentage cost reduction was evaluated.

Statistical Analyses: Data collected were subjected to one-way analysis of variance using SPSS version 13 package and where significant differences are found; the means were compared using Duncan Multiple Range Test of the same package.

III. RESULTS

Performance and Cost of Production Estimate: The influence of composite leaf meal on the performance of swine indicated that there were no significant differences ($P>0.05$) in final live weight and total feed intake among the treatments as presented in Table 3. Highest final live mean weight (41.67 ± 0.84 kg) and highest mean feed intake (75.92 ± 0.06) were recorded in animals fed 10g/kg composite leaf meal, while lowest final live mean weight (37.67 ± 0.84 kg) and lowest mean feed intake (75.57 ± 0.06 kg) were observed in animals fed 40g/kg and 0g/kg composite leaf meal, respectively. The weight gain and the feed conversion ratio of the experimental animals were significantly influenced ($P<0.05$) by the dietary treatments. Highest mean weight gain (23.67 ± 0.51 kg) was recorded in animals fed 10g/kg composite leaf meal, while the lowest mean weight gain (19.33 ± 0.51 kg) was observed in animals fed 40g/kg composite leaf meal. For the feed conversion ratio, the highest mean value (3.95 ± 0.09) was observed in animals fed 40g/kg composite leaf meal and lowest mean value (3.22 ± 0.09) was observed in animals fed 10g/kg composite leaf meal. Generally, the cost of experimental diets (₦/kg) was least in 50g/kg composite leaf meal diet (₦55.44/kg) and highest in 0 g/kg composite leaf meal diet (₦60.43/kg) and the percentage cost reduction increased as the level of the composite leaf meal inclusion increased (1.44 – 8.26%).

Carcass and Organs Characteristics: The results from the carcass and organ evaluation of swine fed composite leaf meal diets indicated that there were no significant differences (P>0.05) in all the parameters measured as shown in Table 4. The eviscerated weights, head weight, carcass length and the relative organs weight of liver, kidney, heart, lungs and spleen were not significantly influenced (P>0.05) by the dietary treatments. Highest eviscerated weight (38.33 kg) was observed in animal fed diet VI (50g/kg composite leaf meal) while the lowest value (36.00 kg) was observed in animal fed diet III (20g/kg composite leaf meal). Animals fed diet VI (50g/kg composite leaf meal) had the highest value for head (3.95kg) while animals fed diet V (40g/kg composite leaf meal) had the lowest value (3.65 kg). The result on eviscerated weight was not significantly different among the treatment mean values but numerically higher in animals fed diet VI (50g/kg composite leaf meal). Animals fed Diet II (10g/kg composite leaf meal) had the highest live weight per animal (41.67 kg).The longest carcass length was recorded in animals fed 50g/kg composite leaf meal (73.00 cm) while the shortest carcass length was recorded in animals fed diet 20g/kg composite leaf meal (69.33cm). Animals fed diet 50g/kg composite leaf meal had the highest liver value (956 g/kg) while animals on diet 0g/kg composite leaf meal had the lowest value (779.33 g/kg). The kidney of animals fed diet II (10g/kg composite leaf meal) had the highest value (133.67 g/kg) while lowest value was recorded in animals fed diet 20g/kg composite leaf meal (114.67 g/kg). Animals on diet I (0g/kg composite leaf meal) had the highest value for heart (153.67 g/kg) while lowest value was observed in diet 30g/kg composite leaf meal (123 g/kg).

Eye Muscle Measurement, Fat Deposition and pH: The influence of composite leaf meal on the eye muscle, fat deposition and pH of the experimental animals indicated that the eye muscle width and midback fat were significantly influenced (P<0.05) by the dietary treatments as presented in Table 5. However, the eye muscle depths, shoulder fat, loin fat and C, K, P were not affected by the dietary treatments. Highest eye muscle width and depth were recorded in animals fed 10g/kg composite leaf meal (7.48 and 3.35 cm, respectively). The lowest eye muscle width and depth were recorded in animals fed 0g/kg composite leaf meal (6.87 and 3.03 cm, respectively). The lowest sub fat loin was recorded in animals fed 20g/kg composite leaf meal (0.72 cm), while highest was recorded in animals fed 10g/kg composite leaf meal (1.25 cm). For C, K, and P; highest values were recorded in 10g/kg composite leaf meal (1.02, 1.28 and 1.08 cm, respectively). Lowest C, K, P values were recorded in animals fed 30g/kg composite leaf meal and 40g/kg composite leaf meal (0.72, 0.63 and 0.60 cm, respectively). For the pH of the meat samples, highest value (5.77 pH) was recorded in animals fed 50g/kg composite leaf meal while lowest value (5.74 pH) was recorded in animals fed 0g/kg composite leaf meal. However, there was no significant (P>0.05) difference in the pH values.

IV. DISCUSSION

All pigs were in apparently good health during this trial. Feed conversion ratio (FCR) was statistically similar in all dietary treatments. The best FCR was recorded in animals fed 10g/kg composite leaf meal diet, which indicated that animals utilized their feed better than those fed other test diets at this stage. Similar final weight, weight gain and feed conversion ratio across treatments suggested that commercial premix could be replaced completely with composite leaf meal without any serious adverse effect on the growth parameters (Adegbenro *et al.,* 2012). In general, the growth parameters measured in animals fed the control diet and those fed the composite leaf meal diets were identical, thus suggesting the nutritional adequacy of the composite leaf meal in replacing the commercial premix in pig diet in sub-tropical Africa where these leaves are abundant. Thus, in the course of world clamour for sustained food security through enhancement of organic farming, the combination of these leaves could be used as a cheaper replacement of commercial premix in swine diets. The economy of production revealed that the cost of feed per kilogram of feed and cost of feed per gain were affected by the dietary treatments. These cost indicators were highest in the control diet and lowest in the 50g/kg composite leaf meal diet, which suggests plausible economic benefit of this inclusion level in pig production. As a result of an increase in percentage cost reduction as the level of the composite leaf meal inclusion increased, it may be safe to completely replace commercial premix with composite leaf meal as this would result in lower the cost of production, increased meat production and affordability by the resource poor. For instance, the complete replacements of commercial premix with composite leaf meal at 5% inclusion level reduced about ₦8.26 per kilogram of feed. This translates to a colossal savings of ₦82,600 per tonne by farmers (Adegbenro *et al.,* 2012). This observation could encourage pig farmers to produce more and thereby making meat available for the populace. Carcass has been shown to be an instrument that determines the relationship between the "whole sale" or "retail cuts" of animals. Observation on the eviscerated weight therefore implies that th e of animals may not necessarily be directly proportional to the performance traits. The result on carcass length indicates that the diets promoted the development of identical carcass length percent. Organs are body parts, composed of several types of tissues, capable of carrying out specialized function (Sarojini, 2005). Among the organs measured are; liver, kidney, heart, lungs and spleen. The organs weight measured in this study were not influenced by the treatments, thus suggesting that the diets were not detrimental. The eye muscle width and eye muscle depth increased with increased live body weight of pigs which indicate that pigs with lighter body weight will possess smaller eye muscle width and eye muscle depth (Gill *et al.,* 1995). Shoulder fat, midback fat and loin fat reduces as the level of the composite leaf meal increases but does not follow any particular trend. This could be linked to the fact that composite leaf meal contains some elements that helps in reducing lipogenesis in the animals. The low pH obtained makes the meat better in terms of appearance and keeping quality. The pH of meat is an important for determining its quality characteristics. Anaerobic glycolysis generates lactate that accumulates, lowering the intracellular pH of meat, so that by 24 hours post mortem the pH has fallen to an ultimate pH of about 5.4 – 5.7 (Chalotte *et al.,* 2003). The ultimate pH depends on glycogen concentration at the time of slaughter (Przybylski *et al.,* 2006). From the current work, the pH values ranged from 5.74 – 5.77 which is still in range of the report of Chalotte *et al.* (2003) and the values of 5.3 – 6.9 reported for pigs by FDA (2012).

Conclusion: The quality of meat depends on numerous factors. The attention is most often focused on the effect on nutrition on meat quality such as pH value, fat quality etc. This research has shown that composite leaf meal will not cause any deleterious effects on the quality of meat produced from these pigs considering the fat quality and pH level. Also, inclusion of composite leaf meal reduced the cost of experimental diets which could help to stem over dependence of pig farmers on importation of conventional premix in developing countries like Nigeria.

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Table.1: The Gross Composition (g/kg) of the Weaner Diets

INGREDIENTS	DIET I	DIET II	DIET III	DIET IV	DIET V	DIET VI
Maize	520.00	510.50	501.00	486.50	472.00	462.50
Wheat offal	20.00	20.00	20.00	20.00	20.00	20.00
Soybean meal	90.00	90.00	90.00	90.00	90.00	90.00
Groundnut cake	100.00	100.00	100.00	100.00	100.00	100.00
Palm kernel cake	90.00	90.00	90.00	90.00	90.00	90.00
Brewer’s dried grain	150.00	150.00	150.00	150.00	150.00	150.00
Bone meal	15.00	15.00	15.00	15.00	15.00	15.00
Oyster shell	5.00	5.00	5.00	5.00	5.00	5.00
Premix	2.50	2.00	1.50	1.00	0.50	0.00
Composite leaf meal	0.00	10.00	20.00	30.00	40.00	50.00
Salt	2.50	2.50	2.50	2.50	2.50	2.50
Vegetable oil	5.00	5.00	5.00	10.00	15.00	15.00
Total	**1000.00**	**1000.00**	**1000.00**	**1000.00**	**1000.00**	**1000.00**
Calculated						
Crude Protein (g/kg)	191.30	193.40	195.50	197.10	198.80	200.90
Metabolizable energy (MJ/kg)	11.87	11.74	11.60	11.58	11.56	11.42
Lysine (g/kg)	7.50	7.50	7.50	7.40	7.40	7.40

Table.2: The Gross Composition (g/kg) of the Grower Diets

INGREDIENTS	DIET I	DIET II	DIET III	DIET IV	DIET V	DIET VI
Maize	560.00	550.50	541.00	526.50	512.00	502.50
Wheat offal	20.00	20.00	20.00	20.00	20.00	20.00
Soybean meal	65.00	65.00	65.00	65.00	65.00	65.00
Groundnut cake	100.00	100.00	100.00	100.00	100.00	100.00
Palm kernel cake	90.00	90.00	90.00	90.00	90.00	90.00
Brewer’s dried grain	120.00	120.00	120.00	120.00	120.00	120.00
Bone meal	15.00	15.00	15.00	15.00	15.00	15.00
Oyster shell	5.00	5.00	5.00	5.00	5.00	5.00
Premix	2.50	2.00	1.50	1.00	0.50	0.00
Composite leaf meal	0.00	10.00	20.00	30.00	40.00	50.00
Salt	2.50	2.50	2.50	2.50	2.50	2.50
Vegetable oil	20.00	20.00	20.00	25.00	30.00	30.00
Total	**1000.00**	**1000.00**	**1000.00**	**1000.00**	**1000.00**	**1000.00**
Calculated						
Crude Protein (g/kg)	176.80	178.80	180.90	182.60	184.20	186.30
Metabolizable energy (MJ/kg)	12.43	12.30	12.16	12.14	12.12	11.98
Lysine (g/kg)	6.70	6.60	6.60	6.60	6.50	6.50

Table.3: Influence of composite leaf meal on the performance and cost of production estimates of swine

Parameters	DIET I	DIET II	DIET III	DIET IV	DIET V	DIET VI	±SEM
Initial live weight (kg)	17.67	17.67	17.67	17.67	17.67	17.67	0.54
Final live weight (kg)	39.33	41.67	38.67	39.33	37.67	41.33	0.84
Weight gain (kg)	21.67^{ab}	23.67^{a}	21.00^{ab}	21.33^{ab}	19.33^{b}	23.00^{ab}	0.51
Total feed intake (kg)	75.57	75.92	75.83	75.62	75.72	75.85	0.06
Feed conversion ratio	3.52^{ab}	3.22^{a}	3.63^{ab}	3.55^{ab}	3.95^{b}	3.31^{a}	0.09
Cost of experimental diets (₦/kg)	60.43	59.56	58.69	57.50	56.31	55.44	
Cost of feed consumed (₦/kg)	4566.70	4521.80	4450.46	4348.15	4263.79	4205.12	
Cost of feed/kg gain ((₦)	210.74	191.04	211.93	203.85	220.58	182.83	
% Cost reduction in experimental diets	-	1.44	2.88	4.85	6.82	8.26	

a-b: Mean within rows having different superscripts are significantly different (P<0.05)

Table.4: Influence of composite leaf meal on the carcass and organs of swine

Parameters	DIET I	DIET II	DIET III	DIET IV	DIET V	DIET VI	±SEM
Live weight (kg)	39.33	41.67	38.67	39.33	37.67	41.33	0.84
Eviscerated weight (kg)	36.67	37.67	36.00	37.00	36.33	38.33	0.76
Head (kg)	3.90	3.88	3.93	3.97	3.65	3.93	0.12
Carcass length (cm)	69.67	71.33	69.33	70.67	71.00	73.00	0.58
Liver (g/kg)	779.33	904.00	800.33	881.33	922.00	956.00	28.95
Kidney (g/kg)	132.33	133.67	114.67	118.67	127.33	118.33	3.09
Heart (g//kg)	153.67	129.33	134.67	123.00	143.00	135.00	4.35
Lungs (g/kg)	311.33	310.33	315.67	374.33	315.33	334.67	9.76
Spleen (g/kg)	54.00	55.67	57.67	63.33	58.67	52.33	2.08

Table.5: Influence of composite leaf meal on the eye muscle and fat deposition of swine

Parameters	DIET I	DIET II	DIET III	DIET IV	DIET V	DIET VI	±SEM
Eye muscle width (cm) (A)	6.87^{a}	7.48^{b}	7.47^{b}	7.46^{b}	7.40^{b}	7.35^{b}	0.007
Eye muscle depth (cm) (B)	3.03	3.35	3.27	3.10	3.32	3.27	0.05
Shoulder fat (cm)	2.47	2.68	2.27	2.15	1.97	2.17	0.10
Midback fat (cm)	1.02^{ab}	1.23^{b}	0.83^{ab}	0.95^{ab}	0.77^{a}	0.85^{ab}	0.06
Loin fat (cm)	0.93	1.25	0.72	0.82	0.80	0.82	0.09
C	0.80	1.02	0.77	0.72	0.75	0.73	0.05
K	0.92	1.28	0.75	0.63	0.63	0.72	0.09
P	0.80	1.08	0.68	0.80	0.60	0.75	0.06
pH	5.74	5.77	5.76	5.77	5.77	5.77	0.05

a-b: Mean within rows having different superscripts are significantly different (P<0.05)