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Performance and cost benefits of growing pigs fed diets containing graded levels of cassava plant meal

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Target Audience: Pig farmers, Swine nutritionists

Abstract

The study evaluated the nutrient digestibility of three standardised Cassava Plant Meals (CPMs) products developed from Tropical Manihot Species (TMS) 30572 with a focus on its efficiency to replace maize completely in the diets of growing pigs and its effect on their growth. The CPM with the best apparent nutrient digestibility (CPM III) was used in the formulation of the basal diet fed to the pigs in the 56-day feeding trial. Twenty growing crossbred pigs (Large White x Hampshire) with initial average weight of 20.00±0.5 kg and of different sexes were randomly allotted to five experimental diets containing 0, 25, 50, 75 and 100 % of maize replaced with CPM as CPM0, CPM1, CPM2, CPM3 and CPM4 respectively. Results showed that cassava plant meal product III (CPM III) had better apparent nutrient digestibility than products I and II. Significant difference ($p<0.05$) existed across dietary treatments for average daily weight gain and feed conversion ratio. However, the final weight of pigs on diet CPM2 (50 % replacement) was highest compared to other dietary treatments. Significant differences ($p<0.05$) also existed for average daily feed intake across the dietary treatments. Feed conversion ratio, feed intake and weight gain values of CPM2 compared favourably with CPM0, while, CPM2 had the least cost of production. It can be concluded that cassava plant meal could completely replace maize in the diets of growing pigs and significantly reduced cost of production.

Keywords: Standardized cassava plant meal; maize; pigs; feed intake; weight gain; cost benefit

Description of Problem

The increasing expansion and demand for livestock products by the teeming human population have been geared towards production of fast-growing species with efficient feed conversion rate [1] such as poultry and pigs. Pig production particularly in the humid tropic of Nigeria represents a cheap source of animal protein intake. However, in recent time, the escalating cost of feed ingredients had continued to be a major constraint. The need to reduce the high cost of feeding which usually makes up 70 – 80 % of the total cost of production [2] led to a continuous search for least cost alternative feedstuffs as suitable replacement for the conventional feed ingredients. Cassava and its products have received attention from swine nutritionists. However, cassava root meal is deficient in essential amino acid such as methionine, cysteine and tryptophan [3, 4]. The development of composite cassava plant

meal (unpeeled roots + leaves + tender cassava stem) as livestock feedstuff for all classes of pigs [5] was in an effort to improve the nutritional profile of cassava meal as replacement for maize. The developed cassava meal attempts to balance the high crude protein, bulk, minerals and vitamins of leaves and tender stem with the energy-rich component of the roots. Works by Akinfala and Tewe [6] and Akinfala *et al.* [7] confirmed the suitability of cassava plant meal (CPM) as good substitute for maize in the diets of pigs. These studies however, did not provide information on the variety of cassava used, age and the length at harvest of the cassava components (tubers, leaves and stems). This research was carried out to evaluate the nutrient digestibility of standardized CPMs with a view to ascertaining its efficiency to replace maize in the diets of growing pigs for effect on growth and cost benefits.

Materials and Methods

The experiment was carried out at the Swine Unit of the Teaching and Research Farm as well as the Poultry Meat Laboratory of the Department of Animal Sciences, Obafemi Awolowo University, Ile–Ife. The cassava tubers of Tropical *Manihot* Species (TMS 30572) aged 24 months was purchased from a commercial farm at Ile-Ife. The cassava tubers were lifted, soil was carefully shaken off the tubers while the cassava leaves were harvested from the plant stem. The tender stems were harvested at 5 cm, usually 6 to 7 nodes from the top of the plant. All the cassava components were harvested between April and June 2017. The fresh tubers (unpeeled cassava tubers) were washed and chopped into small pieces, sun-dried on a concrete floor for an average of 5 – 6 days depending on the intensity of the sunlight, milled and packed into sacks. Also, the fresh cassava leaves and tender stems were sun-dried for about 5-6 days and 9-10 days respectively after harvesting, milled and packed into separate sacks. They were then milled using a grinding machine with 0.3mm sieve. Three composite cassava plant meals were developed in line with reported procedure [8] at ratios 2:1, 2.5:1 and 3:1, so as to have a comparable minimum crude protein content of 10 % as maize. Apparent nutrient digestibility of the three developed cassava plant meals was evaluated using 12 growing pigs with average initial weight of 20.00 $\pm$ 0.5 kg and four diets, with diet 1 containing solely maize while diets 2, 3 and 4 had the three developed CPM products replacing graded levels of the maize fraction respectively. The pigs were kept individually in a metabolic cage (107 cm x 60 cm x 50 cm) locally fabricated with metal for 10 days so as to enable them clear the gut of previous meals since markers were not used. Animals were fed 4 % of their body weight in line with reported procedure [9] and water was supplied *ad libitum*. Total faeces were collected on daily basis for the last 4 days of the metabolic trial. The daily excreta were oven dried at 60 °C for 24 hours, mixed, milled and representative faeces samples were analysed for proximate composition and hydrocyanic acid content, using reported procedure [10] and the modified alkaline picrate method [11] respectively. The proximate composition of the diets and excreta were used to calculate the apparent nutrient digestibility with the equation:

$$\textbf{\% Apparent Nutrient Digestibility} = \frac{\text{Nutrient intake} - \text{Nutrient in faeces}}{\text{Nutrient intake}} \times 100$$

The metabolizable energy content of maize and CPM products were determined using the method of Pauzenga [12].

Table 1: Proximate composition, hydrogen cyanide and energy contents of maize and cassava plant meal products

		Cassava plant meal products				
Proximate Composition (%)	**Maize**	**I**	**II**	**III**	**SEM**	***P***
Moisture	11.95	9.82	9.83	9.94	0.36	0.15
Crude Protein (CP)	10.38	12.62	12.25	12.51	0.56	0.24
Crude Fibre (CF)	2.57^{d}	8.05^{a}	4.69^{c}	6.81^{b}	0.79	0.01
Ash	2.82^{c}	6.69^{a}	6.53^{a}	6.15^{b}	0.60	0.01
Ether Extract (EE)	4.53	5.38	3.12	3.33	0.37	0.30
Nitrogen Free Extract	67.75	57.44	63.58	61.26	0.07	0.28
ME (kcal/kg)	3,156.12	2907.33	2941.84	2963.06	49.70	0.20
HCN (ppm)	ND	30.00^{b}	50.00^{ab}	55.00^{a}	0.10	0.04

Cassava leaf meal + tender stem meal were mixed at ratio 5:1 respectively. The cassava tuber meal was then added and mixed at ratio 2:1 to form CPM product I. CPM Products II and III contained the same components but at a higher ratios of 2.5:1 and 3:1 respectively.

^{a,b,c,d} *means in the same row having different superscripts differ at p<0.05;*

SEM: Standard Error of Means; ND = Not Determined.

For the growth study, the CPM with the best apparent nutrient digestibility profile will be used as the basal diet. Twenty growing pigs were randomly allotted to five dietary treatment groups of 0, 25, 50, 75 and 100 % replacement of maize with cassava plant meal product (CPM) with the best apparent nutrient digestibility profile and given as CPM0, CPM1, CPM2, CPM3 and CPM4 respectively. Each treatment had four pigs, where each pig served as a replicate in a Completely Randomised Design. The percentage gross composition of the experimental diet is shown in Table 2. Water and feed were offered *ad libitum* throughout the fifty-six day duration of the study. The pigs were weighed at the beginning of the experiment and data collected for feed intakes and weight gains were used to calculate the daily feed intake, weight gain and feed to gain ratio. The data were subjected to one-way Analysis of Variance using SAS 9.1® and means were separated using Duncan's new multiple range test.

Table 2: Gross Composition of the experimental diets

	Cassava Levels (%)				
Ingredients (%)	**CPM0**	**CPM1**	**CPM2**	**CPM3**	**CPM4**
Maize	50.0	37.5	25.0	12.5	-
Cassava plant meal	-	12.5	25.0	37.5	50.0
Groundnut cake	10.0	10.0	10.0	10.0	10.0
Soybean meal	8.0	8.0	8.0	8.0	8.0
Palm kernel cake	25.0	25.0	25.0	25.0	25.0
Fish meal	2.0	2.0	2.0	2.0	2.0
Bone meal	1.50	1.50	1.50	1.50	1.50
Oyster shell	3.0	3.0	3.0	3.0	3.0
Premix (Vitamin-Mineral)	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Total	100.0	100.0	100.0	100.0	100.0
Calculated Analysis					
Metabolizable Energy (Kcal/kg)	2798.1	2739.8	2681.5	2623.2	2564.9
Crude protein (%)	18.72	18.69	18.66	18.63	18.61
Crude fibre (%)	5.17	5.58	6.01	6.43	6.86

**Premix (Vit/min): vitamin A 10,000,000 IU; vitamin D 32,000,000 IU; vitamin E 8,000 IU; vitamin K 2,000 mg; vitamin B1 2,000 mg; vitamin B2 5,500 mg; vitamin B61,200 mg; vitamin B12 12 mg; biotin 30 mg; folic acid 600 mg; niacin 10,000 mg; pantothenic acid 7,000 mg; choline chloride 500,000mg; vitamin C 10,000 mg; iron 60,000 mg; Mn 80,000 mg; Cu 800 mg; Zn 50,000 mg; iodine 2,000 mg; cobalt 450 mg; selenium 100 mg; Mg 100,000 mg; anti-oxidant 6,000 mg.*

Results and Discussion

All the cassava plant meals had higher crude protein and fibre contents compared to maize (Table 1). CPM I and CPM II had the highest and least values (12.62 % and 4.69 %) both for the crude protein and fibre contents respectively. The observed variation may be due to the high level of protein rich component of cassava leaf and tender stem meals and the increased fibre level owing to increased inclusion of unpeeled cassava tubers in the composite meal [13, 14]. Lower crude protein content was reported by Akinfala *et al.* [15] however, similar value was reported for the crude fibre of CPM product II. The differences in this studies Akinfala *et al.* [15] may be due to the cassava variety used, age and length at harvest of the different cassava components. Maize had the highest metabolizable energy content (3,156.12 Kcal/Kg) while CPM1 had the least (2,907.33 Kcal/Kg). The HCN content of the three CPMs were significantly different ($p<0.05$) and increased with increasing inclusion level of unpeeled cassava tuber although the values were within the value (100 ppm) recommended as safe level [16].

The apparent nutrient digestibility of maize and the three CPM products is shown in Table 3. There was no significant ($P>0.05$) difference in apparent crude protein, ash and ether extract digestibility. Significant ($P<0.05$) difference existed for the crude fibre and nitrogen free extract. Numerically, ($P>0.05$) all the three CPM products had high nutrient digestibility coefficients. However, reports [17, 18] have shown that the nutrient quality of a feedstuff depends on its evaluation with animals with a focus on its ability to supply energy and protein. CPM product III thus had better crude protein and carbohydrate digestibility, being 16 % and 6 %, as well as 15 % and 7 % higher than products I and II respectively, and this compared well with maize meal especially in terms of crude protein digestibility.

Table 3: Apparent nutrient digestibility of maize and cassava plant meal products

		Cassava plant meal products				
Proximate Composition (%)	**Maize**	**I**	**II**	**III**	**± SEM**	***p***
Moisture	9.77^{a}	22.14^{b}	13.95^{a}	11.42^{a}	1.88	0.01
Crude Protein (CP)	90.88	75.42	84.60	89.93	2.98	0.25
Crude Fibre (CF)	86.10^{a}	63.91^{b}	81.84^{ab}	78.24^{ab}	3.66	0.01
Ash	63.15	58.55	60.01	60.22	1.48	0.82
Ether Extract (EE)	87.95	88.20	85.72	86.11	0.85	0.75
Nitrogen Free Extract (NFE)	71.69^{b}	73.92^{b}	80.74^{ab}	86.91^{a}	2.42	0.03

Cassava leaf meal + tender stem meal were mixed at ratio 5:1 respectively. The cassava tuber meal was then added and mixed at ratio 2:1 to form CPM product I. CPM Products II and III contained the same component but at a higher ratios of 2.5:1 and 3:1 *respectively.*

^{a,b} *means in the same row having different superscripts differ at* $p<0.05$

Growth performance of growing pigs fed graded levels of cassava plant meal-based diets is shown in Table 3. There was no significant difference ($P>0.05$) in the average daily weight gain and feed conversion ratio across dietary treatments. The average daily feed intake differed significantly ($P<0.05$) across dietary treatments, with CPM0 having the least value, while CPM4 had the highest value. The data obtained on average daily weight gain indicated that CPM2 (50 % replacement of maize with CPM) had the highest value while CPM4 had the least. The result obtained on feed conversion ratio showed no significant difference ($P>0.05$) but CPM2 (50 % replacement of maize with CPM) had a better value of 3.31 compared to other dietary treatments.

Table 4: Performance of growing-finishing pigs fed experimental diets

Parameters (kg)	CPM0	CPM1	CPM2	CPM3	CPM4	±SEM	*P*
Initial weight	20.0	19.9	20.0	19.9	20.0	0.33	0.99
Final weight	43.0	42.2	43.1	41.8	41.7	0.39	0.749
Daily weight gain	0.410	0.398	0.413	0.391	0.388	0.01	0.316
Daily Feed Intake	1.37^{b}	1.41^{ab}	1.38^{b}	1.45^{a}	1.47^{a}	0.01	0.014
Feed to gain ratio	3.34	3.54	3.31	3.71	3.79	0.08	0.069

^{a,b} *means in the same row having different superscripts differ at p<0.05*

The cost benefit analysis of growing pigs fed graded level of cassava plant meal as replacement for maize is shown in Table 5. The control diet (CPM0) had significantly (P<0.05) higher cost of feed, average cost of feeding per day and feed cost per kilogram weight gain compared to the CPM diets. This may be due to the higher cost per kg of maize compared to CPM (₦ 180 versus ₦ 121). Results showed significant difference (P<0.05) in the production cost per kg weight gain between the control (CPM0) and CPM based diets with significant reduction as inclusion level of CPM increases up to 50 % of the diet. Studies [19 and 20] have revealed that the use of cassava plant meal as replacement for maize reduced the cost of production.

Table 5: Cost analysis of growing pigs fed graded levels of cassava plant meals

Parameters	CPM0	CPM1	CPM2	CPM3	CPM4	±SEM	*P*
Cost of feed (₦/kg)	165.5^{a}	144.9^{b}	138.8^{b}	132.7^{b}	126.6^{b}	4.77	0.02
Total feed intake (kg)	76.7	78.9	77.3	81.2	82.3	2.03	0.94
*Total cost of feeding (₦)	12.7	11.4	10.7	10.8	10.4	0.37	0.32
Average cost of feeding (₦)	226.7^{a}	204.3^{ab}	191.5^{b}	192.4^{b}	186.1^{b}	5.37	0.04
+Feed cost/kg weight gain	553^{a}	513^{b}	458^{c}	492^{b}	480^{bc}	11.15	0.01

^{a,b} *means in the same row having different superscripts differ at p<0.05*

(₦ = Nigeria currency, Naira) (1 US$ = ₦ 350)

*values expressed in thousand Naira

+ = ₦/Kg

Conclusion and Application

Findings from this study showed that:

1. Cassava plant meal could completely replace maize in the diets of growing pigs;
2. There was no deleterious effects on the growth performance of growing pigs when fed cassava plant meal; and
3. Significant reduction in the cost of production was observed when cassava plant meal completely replaced maize in the diets of growing pigs

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