

## Effects of cassava meal on carcass characteristics and cholesterol of growing pig

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### Abstract

Twenty growing pigs with an average initial weight of  $20.00 \pm 0.5$  kg were randomly assigned to five dietary treatments in a completely randomized design with two replicates per treatment and two animals in each replicate. Cassava Plant Meal (CPM) prepared from sun-dried unpeeled cassava tubers, leaves and tender cassava stems, mixed at ratio 3:1 of unpeeled tuber meal to cassava leaf meal plus tender stem meal with the ratio of cassava leaf meal to tender stem meal as 5:1 was included in balanced rations at graded levels of 0, 25, 50, 75 and 100 percent in a fifty-six days feeding trials. The experimental pigs were weighed before and after slaughtering, dressing percent was evaluated and carcass length and back fat depth were measured on treatment basis. Meat samples were collected at the ribs (2<sup>nd</sup> and 3<sup>rd</sup> and also 12<sup>th</sup> and 13<sup>th</sup>) for cholesterol analysis. The 50 % CPM diet produced the heaviest slaughter weight. There was no significant ( $p > 0.05$ ) difference in the dressing percentage of pigs across dietary treatments although pigs on the control diet dressed well while pigs on 100 % CPM dressed the poorest. The 100 % CPM diet induced the leanest carcass. All the carcass and organ measurements were significantly ( $p < 0.05$ ) affected by dietary treatments. There was non-significant ( $p > 0.05$ ) influence of dietary treatments on total and high density lipoprotein cholesterol although the 50 % CPM diet produced the least and highest values respectively. Low density and very low density lipoprotein cholesterol were significantly ( $p < 0.05$ ) affected by dietary treatments. Replacement of maize by varying levels of cassava plant meal diets enhanced production of leaner carcass.

**Keywords:** Alternative feedstuff; low-fat pork; maize

### Introduction

The exorbitant price and marked shift in availability of conventional feed ingredients particularly dietary energy source for the pig industry (Kozera *et al.*, 2016) implied exploring a wider range of alternative feedstuffs in formulating diets for pigs. Cassava and its products have received attention from swine nutritionist. Globally, cassava production is estimated at 281.1 million metric tonnes with Nigeria as the leading producer (56.8 million metric tonnes) in 2016 (FAO Outlook, 2016). Cassava has been found to be a multi-purpose crop that can thrive in almost every soil and be relied upon to provide the desired relief against the escalating cost of livestock feeds (Tewe, 1997). However, cassava root meals are deficient in essential

amino acids such as methionine, lysine and cysteine (Motagnac *et al.*, 2009; Omede *et al.*, 2018). The option to improve the nutritional profile of cassava meal at reduced cost necessitated the development of composite cassava plant meal (sun-dried unpeeled tubers + leaves + tender cassava stem) as suitable replacement for maize in the diets of pigs (Akinfala and Tewe, 2001). In Nigeria, cassava is presently under-utilised particularly, the leaves and tender stems as they are often left to rot away in farms and homesteads after harvesting the value-giving component (Akinfala *et al.*, 2013). The development of composite cassava meal was in an attempt to balance the high crude protein, bulk, minerals and vitamins of leaves and tender stem with the energy-rich component of the roots.

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Previous studies have established standardised composite cassava plant meal as an acceptable energy source in the diets of growing pigs (Adeyemi and Akinfala 2018). The effects on organ weights, carcass cholesterol and characteristics have not been fully documented. However, research has revealed conflicting results on the replacement of cereal grains by graded levels of cassava meals. Onyimonyi and Okeke (2005), Aro and Akinjokun (2012) observed significant depressing effects on live weight and carcass characteristics. Studies by Sonaiya *et al.* (1982) and Lekule *et al.* (2007) on the effects of dietary cassava on carcass fat and characteristics revealed reduced back fat with no deleterious effects on the carcass quality as the levels of inclusion of cassava meals increased. The cassava variety used, age and the length at harvest of tender cassava stem that formed the composite cassava meal may be the possible causes of the observed variations. Therefore, this study was undertaken to obtain more information on the efficiency of replacing maize with standardised composite cassava plant meals in the diets of growing pigs for organ weights, carcass cholesterol and characteristics with the possibility of contributing to innovative development and appropriate use of alternative feed options for pigs.

### **Materials and methods**

#### ***Experimental location and preparation of ingredients***

The experiment was carried out at the Swine Unit of the Teaching and Research Farm, the Poultry Meat Laboratory of the Department of Animal Sciences, Obafemi Awolowo University (OAU), Ile-Ife, Nigeria and the laboratory of the Department of Animal Science, University of Ibadan, Nigeria. The cassava tubers of tropical *Manihot* Species (TMS 30572) aged 24 months were purchased from local

farmers near the OAU Teaching and Research Farm. Soil was shaken off the lifted cassava tubers, washed and sliced into pieces. The cassava leaves were harvested from the plant stem and the tender stems were harvested at 5cm, usually 6 to 7 nodes from the top of the plant. The tubers, leaves and tender stems were sun-dried on concrete floors for about 7 to 8 days with daily turning, depending on the intensity of the sunlight. They were then milled using a grinding machine with 0.3 mm sieve. The composite cassava plant was mixed in line with the procedure of Akinfala *et al.* (2002) but at a higher ratio of 3:1 so as to have a comparable minimum crude protein content of 10 % as maize.

The proximate analysis, hydrocyanic acid and energy contents of maize and cassava plant meal appear on Table 2. The moisture, crude protein, fibre, ash and ether extract were analysed by the methods of AOAC (2005). Metabolizable energy was determined using the methods of Pauzenga (1985) and HCN content was determined by the modified alkaline picrate methods of Onwuka (2005).

#### ***Experimental animals and design***

Twenty growing crossbred (Large White x Hampshire) pigs of average initial weight of  $20.00 \pm 0.50$  kg were randomly allocated into five dietary treatments and each treatment was replicated twice and housed in groups of 2 (same sex) based on body weight in a concrete floor pen. The experiment was completely randomised design.

#### ***Experimental diets and management of experimental units***

A basal diet of 18 % crude protein was formulated with 50 % maize. The maize was then replaced with the composite cassava plant meal (CPM) at rates of 0, 25, 50, 75 and 100 % in the five CPM experimental diets (Table 1). All the diets contained the same amount of other ingredients. The pigs were group-fed and

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allowed *ad libitum* access to the diets and water was made available in concrete feeding and watering troughs for a period of eight weeks. The pens were regularly cleaned daily while vaccination and

medication schedules were strictly followed. At the end of the experiment, animals were weighed before and after slaughtering to evaluate the dressing percent.

**Table 1: Proximate, HCN and Energy contents of maize and cassava plant meal**

Parameters (%)	Test ingredients	
	Maize	CPM
Dry Matter	88.1	90.1
Crude Protein	10.4	12.5
Crude Fibre	2.6	6.8
Ash	2.8	6.2
Ether Extract	4.5	3.3
NFE	67.8	61.3
HCN (ppm)	ND	55.0
M E (kcal/kg)	3,156.1	2963.1

NFE- Nitrogen Free Extract, ME- Metabolizable Energy

**Table 2: Composition of experimental diets for feeding growing pigs**

Ingredients (%)	Cassava levels (%)				
	0	25	50	75	100
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 B6 1,200 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.

### ***Evaluation of carcass cholesterol and characteristics***

At the end of the experiment, two animals per treatment were sacrificed for carcass analysis. Records of live weight, weights of carcass, organs (lung, kidney, liver and spleen), empty stomach, head, loin, Ham

and shoulder were determined using calibrated weighing scale. The length of carcass and back fat depth were taken on treatment basis using graduated tape rule and plastic metre rule respectively. Meat samples were collected between the second (2<sup>nd</sup>) and third (3<sup>rd</sup>) ribs and also the twelfth

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(12<sup>th</sup>) and thirteenth (13<sup>th</sup>) ribs for cholesterol analysis. The meat samples were saponified following the modified version of the methods described by Stewart *et al.* (1992). After saponification, samples were analysed by High Performance Liquid Chromatography (HPLC) using the procedure of Bragagnolo *et al.* (2001). Cholesterol identification was performed by co-chromatography and by comparing sample retention times with standard retention times (Sigma and Polyscience, U.S.A. ®C8667). Cholesterol quantification was achieved by internal standardisation (0.504 mg for 6-keto-cholestanol, Sigma and Polyscience, U.S.A. ®K1250) using the external standard technique from a standard curve area vs. concentration.

### **Statistical analysis**

The data were subjected to one-way Analysis of Variance (ANOVA) using the general linear model procedure of SAS (2009) while the differences in means were assessed at  $p < 0.05$  (95 % confidence) and separated using Duncan's Multiple Range Test.

### **Results**

The results of proximate analysis, hydrocyanic acid and energy contents of maize and cassava plant meal are summarised in Table 1. There were similarities ( $p > 0.05$ ) in the values obtained for the proximate composition of the CPM and maize. Higher values were obtained for the crude protein and ash contents of CPM than maize by 16.8 % and 54.8 % respectively. Also, for the crude fibre, ether extract and nitrogen free extract values for maize was 61.8 %, 26.7 % and 9.6 % respectively better than cassava plant meal. The metabolizable energy content of maize was 6.12 % higher than that of CPM although, CPM was found to favourably compare with maize.

Pigs on 50 % CPM diet had the highest

slaughter weight being 0.37 %, 2.23 %, 3.13 % and 3.25 % heavier than pigs on 0 %, 25 %, 75 % and 100 % CPM respectively (Table 3). Pigs on control diet had the highest dressing percentage being 2.11 %, 0.80 %, 3.30 % and 3.42 % better dressed than pigs on 25 %, 50 %, 75 % and 100 % CPM respectively. Differences in carcass length were significant ( $p < 0.05$ ). Pigs on the control diets had 14 %, 7 %, 16 % and 3 % increase in carcass length as compared with pigs on 25 %, 50 %, 75 % and 100 % CPM respectively. The longest pigs on control diet dressed well although the shortest pigs on 75 % CPM did not dress the poorest. There was correlation among the slaughter weight, dressing percentage and back fat depth. Significant ( $p < 0.05$ ) difference existed across treatments for back fat depth. Pigs on 100 % CPM diet showed 80 %, 77 %, 70 % and 40 % reduction in back fat depth as compared with pigs on 0 %, 25 %, 50 % and 75 % CPM diets respectively. Increasing CPM levels in the diets did not result in increased weights of the head, ham, loin and shoulder though the values were statistically significant ( $p < 0.05$ ) but did not follow any trend. There were significant ( $p < 0.05$ ) differences in the weights of all measured visceral organs (kidney, lung, spleen and heart) and empty stomach except for the liver. However, all these measurements did not follow any trend or showed impairment on the health status of the animals.

The total and high density lipoprotein cholesterol contents in pigs were not significantly influenced ( $p > 0.05$ ) by dietary treatment (Table 4). Pigs on 50 % CPM diet produced the least total cholesterol while 100 % CPM diets had the highest. Also, high density lipoprotein cholesterol followed the same trend and was 10 %, 3 %, 12 % and 17 % better than pigs on 0 %, 25 %, 75 % and 100 % CPM diets respectively. Control diet had the least low density lipoprotein (LDL) cholesterol

being 21 %, 19 %, 25 % and 20 % better than 25 %, 50 %, 75 % and 100 % CPM diets respectively though the values are not significantly different ( $p > 0.05$ ). Also, there

was no significant effect of dietary treatments on very low density lipoprotein (VLDL) cholesterol. Pigs on 50 % CPM diet produced the least VLDL cholesterol while control diet had the highest value.

**Table 3. Carcass characteristics and organ weights of growing pigs fed experimental diets**

Parameters	Cassava Levels (%)					±SEM	P
	0	25	50	75	100		
Slaughter weight (kg)	42.97	42.17	43.13	41.78	41.73	0.39	0.75
Dressing percentage	76.0	74.4	75.4	73.5	73.4	1.05	0.94
Carcass length (cm)	87.0 <sup>a</sup>	75.0 <sup>b</sup>	81.0 <sup>ab</sup>	73.0 <sup>b</sup>	84.0 <sup>a</sup>	1.93	0.04
Back fat depth (cm)	2.45 <sup>a</sup>	2.21 <sup>b</sup>	1.68 <sup>c</sup>	0.83 <sup>d</sup>	0.50 <sup>e</sup>	0.25	0.01
*Head	5.90 <sup>a</sup>	4.90 <sup>a</sup>	4.55 <sup>b</sup>	5.00 <sup>ab</sup>	5.70 <sup>a</sup>	0.20	0.04
*Ham	40.0 <sup>ab</sup>	38.4 <sup>b</sup>	39.5 <sup>ab</sup>	39.2 <sup>ab</sup>	41.6 <sup>a</sup>	0.46	0.04
*Loin	18.53	24.56	23.61	23.61	22.59	0.28	0.03
*Shoulder	37.1 <sup>a</sup>	37.0 <sup>ab</sup>	32.6 <sup>b</sup>	37.2 <sup>ab</sup>	35.8 <sup>ab</sup>	0.39	0.04
Kidney weight (g)	260 <sup>a</sup>	200 <sup>b</sup>	200 <sup>b</sup>	200 <sup>b</sup>	250 <sup>a</sup>	9.12	0.01
Lung weight (g)	500 <sup>ab</sup>	400 <sup>bc</sup>	400 <sup>bc</sup>	340 <sup>c</sup>	600 <sup>a</sup>	32.52	0.01
Liver weight (g)	1200	1000	900	1020	1100	40.0	0.24
Weight of spleen (g)	200 <sup>a</sup>	100 <sup>b</sup>	100 <sup>b</sup>	80 <sup>c</sup>	200 <sup>a</sup>	17.67	0.01
Heart weight (g)	280 <sup>a</sup>	300 <sup>a</sup>	200 <sup>b</sup>	280 <sup>a</sup>	300 <sup>a</sup>	13.44	0.03
Weight of empty stomach (g)	500 <sup>b</sup>	680 <sup>a</sup>	600 <sup>ab</sup>	580 <sup>ab</sup>	650 <sup>a</sup>	24.62	0.02

Figures with the same super script are not significantly different ( $p > 0.05$ )

\*expressed as percentage of carcass weight

**Table 4: Carcass cholesterol of growing pigs fed graded levels of cassava based diets**

Parameters (mg/100g)	Cassava levels (%)					±SEM	P
	0	25	50	75	100		
Total cholesterol	87.9	83.2	74.9	81.7	89.2	2.50	0.474
HDL Cholesterol	32.6	35.5	36.4	32.1	30.1	1.12	0.426
LDL Cholesterol	22.5 <sup>b</sup>	28.5 <sup>a</sup>	27.9 <sup>a</sup>	29.9 <sup>a</sup>	28.2 <sup>a</sup>	0.92	0.024
VLDL Cholesterol	32.9 <sup>a</sup>	19.2 <sup>b</sup>	10.7 <sup>c</sup>	19.7 <sup>b</sup>	30.9 <sup>a</sup>	1.39	0.015

HDL- High Density Lipoprotein, LDL- Low Density Lipoprotein, VLDL- Very Low Density Lipoprotein

Figures with the same super script are not significantly different ( $p > 0.05$ )

### Discussion

This study indicates that cassava plant meals not only compare favourably with maize especially in terms of crude protein and energy content but that leaner carcass and slaughter weight are enhanced. Also, carcass characteristics, organ weights and cholesterol contents were not negatively affected. Results from the work of Akinfala *et al.* (2013) showed lower crude protein, fibre and ether extract for CPM. The

variation in the proximate values of CPM obtained in this study compared to that of Akinfala *et al.* (2013) may be due to varietal difference (TMS 30572), age of cassava tubers and the length at harvest of tender stems (5cm from the top of the plant).

The finding from the study of Sonaiya and Omole (1977) and Onyimonyi and Okeke (2005) showed reduction in back fat depth when graded levels of cassava peel meals were added to the diets of grower pigs. Herr

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*et al.* (2000) attributed the proportional reduction in back fat depth to the reduction in dietary energy and increased dietary fibre of the diets fed to pigs. The weight of organs and empty stomach did not seem to follow any trend. This result agrees with the work of Onyimonyi and Okeke (2005). The authors fed cassava peel meals to growing pigs and found increasing weight of organs as the levels of cassava peels increased. The observed variations may be due to differences in the levels of HCN present in the cassava variety used. The total cholesterol and high density lipoprotein contents obtained in this study were not in agreement with the findings of Cannata *et al.* (2010) who reported that cholesterol in pork is influenced by fat depth, stage of maturity and diet composition. However, this result is consistent with the findings of Bragagnolo (2009) and Sinclair *et al.* (2010). The total cholesterol content obtained in this study fell within the range (30.00 mg/100g to 86.40 mg/100g) reported by Rubio (2006) for maize based diet. The values of total cholesterol content obtained in this study were lower than the recommended value (119 mg/100g) reported by Honikel (1992) and Rourke *et al.* (1992). In all the measured cholesterol components, 75 % CPM appears to produce the better value in respect of the total, HDL and VLDL cholesterol contents. The differences in the values obtained for the cholesterol content of the carcass was not influenced by the inclusion of CPM diets.

### **Conclusions**

The study showed that replacing maize partially or totally with CPM in the diets of growing pigs reduced the back fat depth.

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