PERFORMANCE, CARCASS CHARACTERISTICS AND ECONOMY OF BROILERS FED DIFFERENTLY PROCESSED COCOYAM (*Colocassia esculenta)* PEEL MEAL

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ABSTRACT

A total of 165 one-day-old Arbor Acre broiler birds were used to investigate the effects of differently processed cocoyam (Colocassia esculenta) peel meal (CYPM) on the performance, economics of production and carcass characteristics of broiler chickens. Five experimental broiler starter and finisher diets were formulated which replaced maize at 0% (control, T1) and 50% soaked CYPM (T2), cooked CYPM (T3), roasted CYPM (T4) and fermented CYPM (T5). The birds were randomly allotted to the five treatments having three replicates of 11 birds each in a completely randomized design. The results showed that final body weight and weight gain had significant ($p < 0.05$) increase for birds fed processed CYPM. Revenue and gross profit significantly increased ($p < 0.05$) across the processed CYPM, with highest revenue and gross profit from birds on T4 (₦450.77) and T5 (₦315.34) respectively. The live weight, carcass weight and dressed weight increased ($p < 0.05$) with the inclusion of processed CYPM. Breast meat also had observable increase ($p < 0.05$) in T5 (21.872g). No effect was seen on the organ weights ($p > 0.05$). It can be concluded that processed CYPM can replace maize up to 50% in practical broiler diet at greater gross profit and increase revenue and can mitigate environmental hazards in communities where cocoyam peels are abundant.

Keywords: Cocoyam peel, Cost benefit, Carcass, Performance, Broiler

J. Agric. Prod. & Tech.2018; 7:17-24

INTRODUCTION

The limitation of poultry production in Nigeria has been hinged particularly on the cost of feed production. Conventional energy source such as maize has not only served as a major ingredient in poultry ration but also as a staple food for humans and as well as raw material for industries which has made feed account for about 70 - 80% of the total cost in most livestock production in developing countries such as Nigeria (Ogungbesan *et al.,* 2014). Maize accounts for about 45-55% of poultry feed, thus any effort to substitute maize in poultry feed will significantly reduce the cost of production (Bamgbose *et al.,* 2004). In view of this, the use of agro-industrial by-products that are not consumed by man, available in large quantities all year round and obtainable at the cheapest or no cost to substitute for the scarce maize in poultry diets is worthy of consideration.

Cocoyam peel is one of the numerous farm wastes that have such potentials. It is a basic waste which is obtained from processing of cocoyam into food. However, its liberal use in monogastric animal feeding could be encumbered by the presence of some anti-nutritional factors (oxalates, phytates, tannins and Saponins), which adversely affect protein and energy utilization in broilers (Agwunobi *et al*., 2002). The use of heat to inactivate these anti-nutritional factors could increase the use of cocoyam peels as a feed component in broiler diets. Heat treatment has been reported to improve the nutritive value and nutrient utilization of the unconventional feedstuffs by animals (Olajide *et al.,* 2011; Amaefule and Onwudike, 2000). This study was conducted to evaluate the performance, carcass characteristics and economy of broiler chickens fed differently processed cocoyam (*Colocassia esculenta)* peel meal.

MATERIALS AND METHODS

Experimental site: The experiment was conducted at the Poultry unit of the Teaching and Research Farm of the Department of Animal Production Technology, Edo State College of Agriculture, Iguoriakhi.

Acquisition and preparation of test material: The cocoyam (*Colocassia esculenta*) tuber used for this study was bought from different markets in Edo State. The cocoyam tubers were washed with water to remove all the sands and dirt before been peeled.

Soaking: The cocoyam peels was soaked for 72hours inside a lid-bucket filled to the brim with water and covered, the water was changed with fresh water after every 24 hours and then sun dried and ground to an ingestible form (0.104mm particle size).

Boiling: Water was boiled to 100^{o}C and the cocoyam peel was immediately immersed for 45 minutes after which it was sun dried and milled**.**

Roasting: Dried pan was put on fire. After it had gotten hot, the crushed cocoyam peel was added to the pan and stirred with spatula homogenously until it had become dried and dark in color. It was packed into a bowl and allowed to cool. The method was carried out locally for duration of 20 minutes and then sundried before it was ground into powdery form.

Fermentation: The fermentation method implored was anaerobic, that is, soaking by sub-merging in water without the interference of oxygen for three (3) days after which the water was drained and the cocoyam peel removed for drying.

Experimental diets: Five experimental starter and finisher diets were formulated. The diets contained 50% of differently processed cocoyam peel meal (CYPM) to replace maize. Treatment 1 (T1) which served as the control without (0%) CYPM consisted of a basal diet with maize, soybean meal and fish meal as sources of energy and protein respectively. Treatments 2, 3, 4 and 5 contained 50% differently processed CYPM as seen in table 1 and 2.

The Metabolizable energy was calculated from the proximate composition data using the formula as described by Pauzenga (1985) as: ME (Kcal/kg) = 37 x %CP + 81.1 x %EE + 35.5 x %NFE.

Experimental birds, design and management: A total of one hundred and sixty five (165) unsexed day old Arbor Acre broilers were randomly allocated to five (5) dietary treatments in a completely randomized design and were replicated three times with 11 birds each. The birds were reared on a deep litter system. Wood shavings were used as litter materials and constant management of litter through aeration and litter changing when wet was carried out. Feed and fresh water were given *ad libitum.* Routine vaccination and medication schedule was properly observed. Records of feed intake and body weight change were taken weekly. The study lasted 42 days. .

Table 1: Gross composition of experimental starter broiler diets

Treatments	T1	T2	T3	T4	T5
% Maize Replaced	0	50	50	50	50
Feed ingredients	CYPM	SCYPM	CCYPM	RCYPM	FCYPM
Maize	50.88	25.44	25.44	25.44	25.44
CYPM	0.00	25.44	25.44	25.44	25.44
Soya bean meal	38.80	38.80	38.80	38.80	38.80
Fishmeal	3.32	3.32	3.32	3.32	3.32
Soya bean oil	2.50	2.50	2.50	2.50	2.50
DCP	1.7	1.7	1.7	1.7	1.7
Limestone	1.4	1.4	1.4	1.4	1.4
Salt	0.3	0.3	0.3	0.3	0.3
+Vitamin-Premix	0.5	0.5	0.5	0.5	0.5
DL-Methionine	0.3	0.3	0.3	0.3	0.3
L-Lysine	0.3	0.3	0.3	0.3	0.3
Total	**100**	**100**	**100**	**100**	**100**
Determined analysis:					
*ME (Kcal/kg)	2927.07	2996.67	2996.67	2996.67	2996.67
Crude Protein (%)	20.00	20.40	20.00	20.00	20.00
Crude Fibre(%)	4.70	5.09	4.50	4.70	4.90
Ash	6.50	6.80	6.40	6.70	7.01
Ether extract	7.30	7.00	7.20	7.20	7.50
Dry matter	91.91	92.50	92.24	92.47	92.20
NFE	61.72	60.71	62.15	62.05	60.64

+ Supreme vitamin-mineral premix contains per 2.5kg the following: Vitamin A, 15,000,000 i.u; vitamin D_3, 3,00,000 i.u, vitamin E, 30,000 i.u, vitamin K, 2,500mgr; Thiamine, B1, 2,000mgr; Riboflavin, B2, 6000mgr; Pyridoxine B6, 4000mg; Niacin, 40,000mgr; vitamin B12, 20mgr; Pantothenic Acid, 10,000mgr; Folic Acid, 1,000mgr; Biotin, 80mgr; Choline Chloride 500mgr; Antioxidant, 125gr; Manganese 96gr; Zinc, 60gr; Iron 24gr; Copper, 6gr; Iodine, 1.4gr; Selenium, 240mgr and cobalt, 120g.

CYPM = Cocoyam peel meal; SCYPM = Soaked cocoyam peel; CCYPM = Cooked cocoyam peel meal; RCYPM = Roasted cocoyam peel meal; FCYPM = Fermented cocoyam peel meal; DCP = Dicalcium phosphate; ME = Metabolizable energy.

*Pauzenga (1985).

Chemical analysis: The cocoyam peel meal, differently processed CYPM and experimental diets were analyzed for proximate composition using the procedure as described by Association of Analytical Chemists (AOAC, 2006).

Evaluation of Carcass Quality: At the end of 42 days feeding trial, two birds per replicate were randomly selected with their live weights taken before carcass evaluation after fasting them for 16 hours. The birds were slaughtered by severing their jugular veins with a sharp surgical knife. The birds were soaked in hot water, defeathered and washed. The internal organs were neatly removed and weighed (evisceration) followed by the cutting of the carcass into retail parts and weighed. Dressed weight was recorded after evisceration. The weights were expressed as percentages of dressed weight.

Statistical analysis: Data obtained were statistically analyzed using Analysis of Variance (ANOVA) of General Linear Model (GLM) procedure of SAS (2006). Means were separated using the Duncan multiple range test option of the same statistical package.

Table 2: Gross composition of experimental finisher broiler diets

Treatments	T1	T2	T3	T4	T5
% Maize replaced	0	50	50	50	50
Feed ingredients	CYPM	SCYPM	CCYPM	RCYPM	FCYPM
Maize	55.00	27.50	27.50	27.50	27.50
CYPM	0.00	27.50	27.50	27.50	27.50
Soya bean meal	32.00	32.00	32.00	32.00	32.00
Fishmeal	3.9	3.9	3.9	3.9	3.9
Soya bean oil	3.3	3.3	3.3	3.3	3.3
DCP	2.50	2.50	2.50	2.50	2.50
Limestone	2.00	2.00	2.00	2.00	2.00
Salt	0.3	0.3	0.3	0.3	0.3
+Vitamin-Premix	0.4	0.4	0.4	0.4	0.4
DL-Methionine	0.3	0.3	0.3	0.3	0.3
L-Lysine	0.3	0.3	0.3	0.3	0.3
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Determined analysis:					
*ME (Kcal/kg)	2983.19	3058.43	3058.43	3058.43	3058.43
Crude Protein (%)	18.03	18.70	18.44	19.33	18.03
Crude fibre (%)	4.60	4.70	4.70	4.50	4.70
Ash	6.7	6.50	7.11	7.08	6.90
Ether extract	6.90	7.05	6.70	7.00	7.10
Dry Matter	92.62	91.85	92.10	91.19	92.19
NFE	63.77	63.05	63.05	62.09	63.27

+ Supreme vitamin-mineral premix contains per 2.5kg the following: Vitamin A, 15,000,000 i.u; vitamin D_3, 3,00,000 i.u, vitamin E, 30,000 i.u, vitamin K, 2,500mgr; Thiamine, B1, 2,000mgr; Riboflavin, B2, 6000mgr; Pyridoxine B6, 4000mg; Niacin, 40,000mgr; vitamin B12, 20mgr; Pantothenic Acid, 10,000mgr; Folic Acid, 1,000mgr; Biotin, 80mgr; Choline Chloride 500mgr; Antioxidant, 125gr; Manganese 96gr; Zinc, 60gr; Iron 24gr; Copper, 6gr; Iodine, 1.4gr; Selenium, 240mgr and cobalt, 120g.

CYPM = Cocoyam peel meal; SCYPM = Soaked cocoyam peel; CCYPM = Cooked cocoyam peel meal; RCYPM = Roasted cocoyam peel meal; FCYPM = Fermented cocoyam peel meal; DCP = Dicalcium phosphate, ME = Metabolizable energy.

*Pauzenga (1985).

RESULTS AND DISCUSSION

Proximate composition of CYPM: The result of the proximate composition of the experimental diets and cocoyam peel meal is presented in Table 3 below. The analysis showed that cocoyam peel contained 5.25% crude protein, 5.10% crude fiber, 4.6% ether extract, 8.9% ash and 71.05% NFE and 3089.59Kcal/kg metabolizable energy. These values were slightly higher than the values reported by Alinnor and Akalezi (2010). The observed CP was particularly high when compared to other root crops as reported by (Hussain *et al.,* 2004). The differences observed could be due to differences in cocoyam varieties, peeling methods or soil types. The crude protein (5.25 – 11.03%) and metabolizable energy (3089.59 - 3339.17kcal/kgDM) content of cocoyam meal increased upon processing while the ash (6.80 – 8.90%), EE (3.60 – 4.50%) and the dry matter (91.73 – 93.06%) decreased after processing.

Table 3: Proximate analysis of test ingredients

Components (%)	CYPM	SCYPM	CCYPM	RCYPM	FCYPM
Dry Matter	93.06	92.51	93.03	92.35	91.73
Crude Protein	5.25	9.80	10.68	8.75	11.03
Ash	8.90	6.80	7.20	8.50	7.20
Ether Extract	4.60	3.70	4.50	3.80	4.20
Crude fibre	5.10	4.90	5.70	5.60	4.60
NFE	71.05	74.8	71.92	73.35	72.97
*ME (Kcal/kg)	3089.59	3318.07	3313.27	3235.86	3339.17

CYPM = cocoyam peel meal; SCYPM = soaked cocoyam peel; CCYPM = Cooked cocoyam peel meal; RCYPM; Roasted cocoyam peel meal; FCYPM = fermented cocoyam peel meal. *Pauzenga (1985).

Growth performance: Data on the performance response are presented in Table 4. The result reveals a significant ($p < 0.05$) increase in the final body weight of birds fed processed CYPM when compared with the control. It was observed that the average weight gain (353g) of birds fed SCYPM (T2) was significantly ($p < 0.05$) higher than those (232g/bird) on control diet. The improved weight gain of the birds fed the processed CYPM may be associated with the beneficial effect of the different processing methods in enhancing the nutritional value and digestibility of nutrients (Olajide *et al.,* 2011). The improved digestibility could be as a result of the inactivation of the anti-nutritional factors such as oxalates, phytates, tannins and saponins, which interferes with the digestive process (Ghazi *et al.,* 2002). The dry heat from roasting also destroys the toxic enzymes which interfere with digestion and growth in all animals. The lower weight gain (232g/bird) observed for birds fed diet with un-processed CYPM (T1) suggests that nutrients in the CYPM were not as available as in the processed CYPM diets. Tannins and trypsin inhibitors have been reported to affect nutrient availability and utilization by monogastric animals (Kocher *et al.,* 2002). Therefore, the poor body weight of the broilers could be due to the poor digestibility and absorption of nutrients in the un-processed CYPM diet. Feed intake and FCR were not significantly ($p > 0.05$) affected by birds fed the experimental diet. The result of the feed conversion ratio shows that there was numerical improvement of the birds fed with soaked CYPM (2.52). The performance of broiler birds on processed CYPM-based diets was superior to those birds on control diet. Improvement in the growth performance (Final weight and weight gain) could be attributed to the different processing methods which reduced the total anti-nutritional effect of the peels (Ahaotu *et al.,* 2010).

Table 4: Growth performance of broilers fed processed cocoyam peel meal diets

Treatments	T1	T2	T3	T4	T5	
% Replacement	0	50	50	50	50	
Feed ingredients	CYPM	SCYPM	CCYPM	RCYPM	FCYPM	SEM
Parameters:						
Initial BW (g)	569.67^{c}	899.00^{b}	1027.0^{a}	1048.33^{a}	933.33^{b}	2.83
Final BW (g)	801.67^{b}	1252.0^{a}	1335.3^{a}	1348.33^{a}	1192.00^{a}	3.14
Feed intake (g)	657.3	883.7	861.7	989.0	792.7	4.36
Weight gain(g)	232.00^{b}	353.00^{a}	308.3^{ab}	300.00^{ab}	258.67^{ab}	2.48
FCR (Feed:gain)	2.83	2.52	2.85	3.85	3.10	0.23

$^{a-c}$Means with different superscript within the same row are significant ($p < 0.05$).

BW = Body weight; FCR = Feed Conversion Ratio

Economics of production: Table 5 summarized the economics of production of broiler chickens fed diets with processed CYPM. The result revealed that the differently processed CYPM had significant effect ($p < 0.05$) on the cost parameters measured. It was observed that feed cost/weight gain, revenue and gross profit increased significantly ($p < 0.05$) across the processed CYPM diets. The increase in profit margin of birds fed differently processed CYPM agrees with previous reports by (Ukachukwu and Anugwa, 1995). The results of this study showed that cocoyam peel meal diet prove to be beneficial in terms of revenue and profit maximization. There was a significant reduction in feed cost and cost of feed consumed per bird across the processed diets when compared with the control (T1). Feed cost is the highest recurrent cost in poultry production and thus has a major impact on the profitability of the industry and affordability of poultry product for the consumers. Increase in the price of feed ingredient has severe negative impact on livestock production in developing countries. Cost of production increased in the CCYPM (₦113.82kg), RCYPM (₦166.50/kg) and FCYPM (₦129.24/kg) diets. This result disagrees with (Ogundipe and Sanni, 2002) who advised the use of agro industrial by-product for the sole purpose of reducing cost of production which constitutes 60-70% of the total cost. Nevertheless, there was a significant decrease in the cost of production for the SCYPM (₦93.50/kg).

Table 5: Economics of production of broilers fed processed cocoyam peel meal diets

Treatments	**T1**	**T2**	**T3**	**T4**	**T5**	
% Replacement	**0**	**50**	**50**	**50**	**50**	
Feed ingredients	**CYPM**	**SCYPM**	**CCYPM**	**RCYPM**	**FCYPM**	**SEM**
Parameters:						
Feed cost (₦)/Kg	136.740^{a}	116.11^{b}	115.72^{b}	116.05^{b}	115.88^{b}	0.45
Cost of feed Consumed /bird (₦)	160.38^{a}	134.62^{b}	132.27^{b}	128.16^{b}	131.38^{b}	1.05
Cost of FI/kg BWG (₦)	390.28^{b}	288.80^{e}	337.69^{d}	451.95^{a}	362.88^{c}	1.05
Cost of Production (₦/kg)	93.56^{d}	93.50^{d}	113.82^{c}	166.50^{a}	129.24^{b}	0.60
Revenue (₦kg)	286.66^{c}	389.97^{b}	424.30^{ab}	450.77^{a}	445.38^{a}	1.51
Gross profit (₦/kg)	186.27^{c}	289.73^{b}	303.92^{a}	286.17^{b}	315.34^{a}	0.93

$^{a-c}$Means with different superscript within the same row are significant ($p < 0.05$)

Carcass characteristics: Table 6 shows the carcass and organ characteristics of birds fed differently processed cocoyam peel meal. Birds fed processed CYPM had significant increase ($p < 0.05$) in their live weight, carcass weight and dressed weight than those fed control diet. This is in agreement with Ologhobo and Adejumo (2011) who reported that birds fed with processed cocoyam gain significantly higher weight more than those on the control diet. The improved live weight of birds fed CCYPM (1335g) and RCYPM (1348g) may be associated with the beneficial effect of boiling and roasting which resulted in better nutritive value and digestibility (Ahaotu *et al.,* 2010). Agwunobi and Abdulrashid (2009) reported lower levels of phytate, tannin, saponin, and cyanide (HCN) in the boiled sundried taro cocoyam meal compared with higher amount in raw (unboiled) taro cocoyam meal. Hence the anti-nutritional factor (ANF) in the processed CYPM had insignificant effect on the birds. No significant difference ($p > 0.05$) were observed in the dressing percentage of birds fed experimental diets, though higher numerical value (59.26g) was observed in birds fed the RCYPM diet. Cut parts weight that differs significantly ($p < 0.05$) among the treatment groups were the breast muscle, drumstick, pancreas and lung. Assessment of visceral such as gizzard, heart, liver, spleen and kidney showed that they were not significantly influenced by the processing methods. This result is in agreement with Ologhobo and Adejumo (2011). The improvements observed for these parameters in the present study conforms with the earlier assertion of (Ahaotu *et al.,* 2010) that heat processing of CYPM improves performance of animals. .

Table 6: Carcass characteristics of broilers fed processed cocoyam peel meal diets

Treatments	**T1**	**T2**	**T3**	**T4**	**T5**	
% Replacement	**0**	**50**	**50**	**50**	**50**	
Feed ingredients	**CYPM**	**SCYPM**	**CCYPM**	**RCYPM**	**FCYPM**	**SEM**
Parameters:						
Live weight(g)	801.67[b]	1252.00[a]	1335.33[a]	1348.33[a]	1192.00[a]	5.44
Carcass weight(g)	758.33[b]	1185.67[a]	1243.67[a]	1281.33[a]	1133.67[a]	5.92
Dressed weight(g)	650.0[b]	1019.0[a]	1010.3[a]	1031.3[a]	917.00[a]	6.56
Dressing (%)	51.58	53.18	50.67	59.26	57.55	4.99
Prime cuts:						
Wings	9.70	8.93	9.701	8.62	10.20	0.55
Breast	13.40[c]	16.06[bc]	20.95[a]	19.52[a]	21.87[a]	0.92
Back	13.44[ab]	11.34[b]	13.65[ab]	13.77[ab]	15.43[a]	0.69
Drumstick	9.56[b]	10.389[ab]	12.66[a]	11.75[ab]	12.34[a]	0.68
Thigh	9.55	9.35	8.33	8.71	10.51	0.88
Organ weights						
Heart	0.39	0.33	0.41	0.33	0.36	0.15
Gizzard	2.26	2.28	2.58	2.95	2.86	0.36
Liver	1.57	1.67	1.59	1.50	1.62	0.38
Spleen	0.06	0.05	0.07	0.07	0.06	0.09
Lung	0.24[bc]	0.23[c]	0.30[ab]	0.29[ab]	0.31[a]	0.11
Kidney	0.10	0.10	0.10	0.08	0.08	0.08
Pancreas	0.16[b]	0.21[ab]	0.20[ab]	0.21[ab]	0.29[a]	0.13

[a-c]Means with different superscript within the same row are significant ($p < 0.05$)

CONCLUSIONS

- Processed cocoyam peel meal can be utilized as a source of energy in poultry diets.
- The nutritive value of cocoyam peel meal can be improved by heat processing.
- Replacement of processed cocoyam peel meal with maize up to 50% level elicited a good performance in broiler chickens without any adverse effect with higher revenue and gross profit despite the high cost of production.
- The use of cocoyam peels will mitigate environmental hazards in communities where cocoyam peels are abundant as nuisance.

Acknowledgement: We acknowledge the technical advice of Dr. Olatunbosun Odu and laboratory expertise of Mr. Adelani and Mr. Salau T.A of the Department of Animal Science, University of Ibadan, Ibadan, Nigeria.

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