Nigerian J. Anim. Sci. 2011, 13:51-58

Performance, Nutrient Digestibility and Carcass Characteristics of Broilers Fed Cocoa Pod Husk-Based Diets

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Target Audience: Poultry farmers, livestock feed millers, animal nutritionists and researchers

Abstract

The study examined the effect of replacing maize with cocoa pod husk (CPH) in the diets of broilers on the performance, nutrient digestibility and carcass characteristics of the birds. CPH was sun-dried, milled and incorporated in the diets at 0, 20, 40, 60 and 80% replacement levels for maize. There was a significant decrease (P < 0.05) in feed intake, live weight gain and feed conversion ratios (FCR) with increasing levels of CPH in the diets. However, birds fed 20% CPH had the highest feed intake and live weight gain. There were no significant differences (P > 0.05) in the FCR of the birds fed 0, 20 and 40% CPH replacement for maize. Nutrient digestibility coefficients decreased significantly (P < 0.05) with increasing levels of CPH in the diets. The live and dressed weights of the birds decreased with increasing CPH levels. The liver weight increased with increasing CPH levels, while other organ weights did not follow any regular pattern as revealed by the influence of CPH on the birds. This study suggests that maize in broiler diets could be replaced with CPH up to 20% level.

Key words: Coco pod husk, broiler, performance, nutrient digestibility, carcass characteristics

Description of problem

Expansion of the poultry industry depends to a large extent on the availability of good quality feeds in sufficient quantity and at a price that both the producers and consumers alike can afford. This is particularly important for intensive poultry enterprise where performance depends almost entirely on the use of balanced rations. The high cost of conventional sources of protein and energy is largely responsible for the present high price of finished feeds. Thus, the potential value of agro-industrial byproducts and their maximum inclusion rate in diets depends on their nutritive value, their safety to animal health and availability to farmers.

Nigeria is still confronted with the problem of proper feeding of livestock species because of the competition between man and animal for the conventional protein energy feedstuffs

(1). These authors noted that maize, which is the major source of energy in poultry feed is also a significant source of food for man; therefore, to arrest the escalating feed cost, there is need to evaluate agricultural byproducts produced in Nigeria, which has no direct human food value.

Among such agro-byproducts are cocoa pod husk (CPH), kola husk (KH), discarded cocoa beans (DCB), and kola testa (KT), which were considered as wastes. The nutritive values of some of these byproducts have been extensively studied with encouraging results to supporting the performance of livestock and poultry (2) and (3). These authors recommended that the inclusion of CPH should not exceed 20% because there was a decrease in the body weight gain and egg production beyond 10% CPH levels. This experiment was aimed at determining the optimal replacement level of maize with CPH and its effects on the performance and carcass characteristics of broilers.

Materials and Methods

The feeding trial was carried out at the Poultry Experimental Unit of the Federal College of Animal Health and Production Technology, Ibadan. The experiment lasted eight weeks.

Cocoa pod husk (CPH) was collected from the Fermentary Unit of the Cocoa Research Institute of Nigeria (CRIN), Ibadan. Other ingredients were purchased from Caps Feed Mill, Oluyole Estate, Ibadan. The CPH was sun-dried for four weeks and milled before incorporating it in the broiler diets. One hundred and fifty (150) day old Anak 2000 broilers were randomly allotted to five treatments A, B, C, D and E in completely randomized design (CRD). Each treatment consisted of three replicates of 10 birds per replicate. Treatment A served as the control diet without CPH meal, while Treatments B, C. D and E contained 20, 40, 60 and 80% CPH replacing maize in the diets. The composition of the experimental starter and finisher diets are presented in Tables 1 and 2. Feed and clean water were supplied to the birds *ad-libitum* during the experimental period.

At the 8th week, two birds from each replicate were randomly selected and placed in the metabolic cages and acclimatized for five days. Total feacal collection lasted five days. The collected feaces were weighed, mixed, wrapped in aluminum foil and dried in a forced air circulation oven at 60^0C until constant weight was obtained for dry matter determination.

Table 1: Gross composition of starter diets (%)

Ingredients	A (0% CPH)	B (20% CPH)	C (40% CPH)	D (60% CPH)	E (80% CPH)
Maize	42.28	36.22	27.17	18.13	9.06
CPH	-	9.06	18.11	27.17	36.22
Fish meal	4.00	4.00	4.00	4.00	4.00
Soybean cake	26.22	26.22	26.22	26.22	26.22
Wheat offal	9.00	9.00	9.00	9.00	9.00
Groundnut cake	10.00	10.00	10.00	10.00	10.00
Oyster shell	2.00	2.00	2.00	2.00	2.00
Bone meal	2.50	2.50	2.50	2.50	2.50
* Premix	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Calculate analysis					
Crude protein	24.45	24.55	24.32	24.05	23.78
Crude fibre	3.92	6.40	8.89	11.30	13.90
ME (kcal kg^{-1})	2809.56	2695.72	2573.73	2451.61	23.26.61

The CPH used contained 88.57% dry matter, 7% crude protein, 29.60% crude fibre, 1.09 ether extract, 13.37% ash, 48.94% nitrogen free extract and 2085.53 kcal kg^{-1} Metabolizable Energy (ME) for CPH was calculated using Pauzenga equation (12).
37% x % crude protein + 81.8 x % crude fat + 35.5 x % nitrogen free extract

* Vitamin trace mineral mix manufactured by Pfizer Feed Company, Lagos for starting chickens to supply/kg feed the following vitamin A (I.U), 10,000; Vit. D (I.U), 2,000; Vit. E, 2.5; Vit. K (mg), 20; riboflavin (mg), 4.2; panthothenic acid (mg), 0.5; nicotinic acid (mg), 20; chlorine (mg), 300.0; folic acid (mg), 0.5; methionine (mg), 0.225 Mn (mg), 56.0; I (mg), 1.0; Fe (mg), 20.0; Cu (mg), 10.0; Zn (mg), 50; Co (mg), 1.25.

The dried samples were milled in a hammer mill before chemical analyses were carried out. The proximate composition of the experimental diets, test ingredients and feacal samples were analyzed according to the methods of (4). At the end of the experimental period, three birds from each treatment were selected, starved overnight, weighed and slaughtered. The carcasses were dressed, weighed and the dressing percentage determined. Some organs were also selected, weighed and their relative weights determined as the percentage of the live weights. The data collected were subjected to analysis of variance (5) and treatment means, which were significantly different were separated using Duncan multiple range test by (6).

Table 2: Gross composition of finisher diets (%)

Ingredients	A (0% CPH)	B (20% CPH)	C (40% CPH)	D (60% CPH)	E (80% CPH)
Maize	57.66	46.13	34.60	23.06	11.53
CPH	-	11.53	23.06	34.60	46.13
Fish meal	6.00	6.00	6.00	6.00	6.00
Soybean cake	9.84	9.84	9.84	9.84	9.84
Wheat offal	10.00	10.00	10.00	10.00	10.00
Groundnut cake	10.00	10.00	10.00	10.00	10.00
Palm oil	1.00	1.00	1.00	1.00	1.00
Oyster shell	2.00	2.00	2.00	2.00	2.00
Bone meal	2.50	2.50	2.50	2.50	2.50
* Premix	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculate analysis					
Crude protein	20.42	19.54	19.08	19.08	18.15
Crude fibre	3.18	10.07	12.34	14.60	15.61
ME (kcal kg^{-1})	2808.24	2676.89	2572.24	24.67.92	23.63.50

* Vitamin trace mineral mix manufactured by Pfizer Feed Company, Lagos to supply/kg feed the following vitamin A (I.U), 10,000; Vit. D (I.U), 2,000; Vit. E, 2.5; Vit. K (mg), 20; riboflavin (mg), 4.2; panthothenic acid (mg), 0.5; nicotinic acid (mg), 20; chlorine (mg), 300.0; folic acid (mg), 0.5; methionine (mg), 0.225 Mn (mg), 56.0; I (mg), 1.0; Fe (mg), 20.0; Cu (mg), 10.0; Zn (mg), 50; Co (mg), 1.25.

Results and Discussion

The results obtained from this study showed an overall significant decreased ($P < 0.05$) in feed intake with increasing levels of CPH in the experimental diets contrary to the findings of (7) and (8).

The decreasing live weight and weight gains observed with the increasing levels of CPH in the experimental rations agreed with the observations of (9) that 10% CPH in the diet gave best performance results in broiler chickens. This decreasing trend in the growth rate might be attributed to the influence of the crude fibre content of the diets which depressed the feed intake. The influence of high lignin, pectin substances and high calcium content of the CPH might have contributed to the poor nutrient utilization of the CPH, especially those processed along with the epicarp (10).

It has been observed that available energy is often correlated with the crude fibre content of a feedstuff and that increasing levels of a highly fibrous feedstuff in a ration increase the crude fibre content of the ration, hence decreasing the amount of available energy and producing lower growth rate (3).

Table 3: Proximate composition of starter diets

Components (%)	A (0% CPH)	B (20% CPH)	C (40% CPH)	D (60% CPH)	E (80% CPH)
Dry matter	90.86	90.92	91.21	90.74	90.17
Moisture	9.14	9.08	8.79	9.26	9.83
Ash	6.93	7.72	8.21	8.32	9.23
Crude protein	23.91	23.62	22.56	22.21	22.19
Ether extract	13.39	12.46	11.51	9.69	8.21
Crude fibre	5.69	6.74	8.59	9.38	10.92
NFE	40.94	40.38	40.34	41.14	39.64

Table 4: Proximate composition of finisher diets

Components (%)	A (0% CPH)	B (20% CPH)	C (40% CPH)	D (60% CPH)	E (80% CPH)
Dry matter	90.26	89.04	88.89	89.12	89.36
Moisture	9.74	10.96	11.11	10.88	10.64
Ash	6.21	7.08	8.55	8.96	9.84
Crude	20.88	19.65	18.84	17.95	17.78
protein	13.32	12.10	10.35	9.86	7.98
Ether	5.32	10.68	11.46	13.52	15.12
extract	44.53	39.53	39.69	38.83	38.64
Crude fibre					
NFE					

NFE=Nitrogen free extract

The overall feed conversion ratio (FCR) showed no significant differences ($P < 0.05$) among birds fed 0 – 40% CPH, while diets D and E (60 and 80% CPH) respectively were less efficiently utilized. This indicates that broilers could efficiently utilize CPH at up to 40% replacement level for maize.

The results for nutrient digestibility are presented in Table 6. The dry matter, crude protein, crude fibre, ether extracts and ash digestibility coefficients decreased significantly ($P < 0.05$) with increasing levels of CPH. This could be attributed to the effect of high crude fibre levels of the CPH coupled with the effect of theobromine, an anti-nutritional factor. This is in consonance with the reports of (10) who observed a reduction in the digestion and absorption of nutrients by animals fed on high levels of theoromine. This finding also agrees with the report of (11), that fibre increases the bulkiness of a diet and limits the weight of feed taken by birds thereby imposing a physical limitation upon the intake of digestible nutrients

Table 5: Performance of broilers fed varying levels of CPH in replacement for maize

Parameters	A (0% CPH)	B (20% CPH)	C (40% CPH)	D (60% CPH)	E (80% CPH)	SEM
Initial live weight	49.50	49.95	50.00	49.98	50.12	
Feed intake (g/bird)						
0 – 28 days	1838.00[a]	1891.00[a]	1624.00[b]	1463.00[c]	1377.00[d]	55.27
28 – 56 days	4638.00[b]	5350.00[a]	4300.00[c]	3452.00[d]	3580.00[d]	128.85
0 – 56 days	6476.00[b]	7241.00[a]	5924.00[c]	4915.00[d]	4957.00[d]	180.65
Live weight (g/bird)						
0 – 28 days	638.89[b]	733.33[a]	511.11[c]	492.22[c]	252.22[d]	42.59
28 – 56 days	1689.50[a]	1699.95[a]	1377.67[b]	1027.65[c]	922.35[d]	22.49
Weight gain(g/bird)						
0 – 28 days	589.39[b]	683.83[a]	461.11[c]	442.24[c]	202.22[d]	24.66
28 – 56 days	1050.61[a]	966.62[b]	866.56[c]	535.43[c]	670.13[d]	79.35
0 – 56 days	1640.00[a]	1650.00[a]	1327.67[b]	977.67[c]	872.23[d]	22.42
Feed conversion ratio (FCR)						
0 – 28 days	3.12[b]	2.77[c]	3.52[b]	3.31[b]	6.81[a]	0.61
28 – 56 days	4.41[c]	5.53[b]	4.96[bc]	6.45[a]	5.34[b]	0.81
0 – 56 days	3.95[b]	4.39[b]	4.46[b]	5.03[a]	5.68[a]	0.66
Mortality (%)						
0 – 28 days	5.00	0.00	5.00	0.00	5.00	0.31
28 – 56 days	-	-	-	-	-	-
0 – 56 days	-	-	-	-	-	-

[abcd] means with the same superscripts on the same row do not differ significantly ($p > 0.05$)

Table 6: Apparent digestibility of nutrients of birds fed varying levels of CPH for maize

Nutrients	A (0% CPH)	B (20% CPH)	C (40% CPH)	D (60% CPH)	E (80% CPH)	SEM
Dry matter	69.22[a]	60.02[a]	50.24[b]	46.81[b]	31.48[c]	9.95
Crude protein	61.52[a]	63.38[a]	45.62[b]	39.14[c]	32.43[d]	5.54
Crude fibre	56.17[a]	65.83[a]	44.40[b]	43.40[b]	40.06[b]	9.75
Ether extract	70.96[a]	51.56[b]	55.53[b]	46.74[c]	42.76[c]	7.83
Ash	69.31[a]	52.47[b]	51.26[b]	41.62[c]	37.97[c]	6.65

[abcd] means with the same superscripts on the same row do not differ significantly ($p > 0.05$)

The results obtained from the experiment showed that for feed to be adequately digested, CPH should not exceed 20% replacement level for maize.

The data obtained for the carcass characteristics and selected organ weights of the broilers fed varying levels of CPH are presented in Table 7. There was a significant ($p < 0.05$) decrease in the live weight and dressed weights of the birds with increasing levels of CPH in the diets. Birds fed diet B (20% CPH replacement for maize) performed better on these parameters than those of the control diet, while those on higher CPH levels had lower weight. This is an indication that high levels of CPH in broiler ration are detrimental to growth and muscle deposition. The mortality recorded showed that CPH was not responsible for the losses that occurred in the various treatments during the experimental period since birds fed on the control diet also had mortalities.

Table 7: Carcass characteristics and selected organ weights of broilers fed CPH for maize

Carcass parameters	A (0% CPH)	B (20% CPH)	C (40% CPH)	D (60% CPH)	E (80% CPH)	SEM
Live weight (g)	1770.00^{b}	1950.00^{a}	1550.00^{c}	1383.00^{d}	783.33^{e}	56.40
Dress weight (g)	1550.00^{b}	1700.00^{a}	1367.00^{c}	1220.00^{d}	667.00^{e}	28.31
Dressing (%)	87.26	87.13	88.45	87.84	85.00	4.29
Organ weights						
(% live weight)	1.74	1.79	1.74	1.88	2.04	0.31
Gizzard	0.08^{a}	0.10^{a}	0.04^{b}	0.04^{hb}	0.06^{a}	0.03
Spleen	0.12	0.13	0.27	0.26	0.49	0.38
Proventriculus	0.28^{a}	0.32^{a}	0.29^{a}	0.23^{b}	0.31^{a}	0.09
Heart	2.10^{b}	2.00^{b}	2.35^{a}	2.45^{a}	2.94^{a}	0.61
Liver	0.24^{a}	0.29^{a}	0.21^{a}	0.19^{b}	0.20^{b}	0.08
Crop						

[abcde] means with the same superscripts on the same row do not differ significantly ($p > 0.05$)

The results obtained in this study could be as a result of the higher CPH levels of inclusion and higher crude fibre levels of the diets, which might have prevented the utilization of other nutrients, especially protein, hence effect on growth and muscle deposition (10) and (11). The results of nutrient digestibility also confirmed this observation.

The gizzard and proventriculus showed no significant differences ($p > 0.05$) with increasing CPH levels. The crop, spleen and heart weights also did not show any significant differences ($p > 0.05$) neither did their weights follow any regular pattern. This made it difficult to ascertain the effect of increased CPH level on these organs; however, the increasing weight of the liver might be traced to the influence of theobromine, which might be present in the CPH.

Conclusion and recommendation

The results obtained in this study showed that

1. The inclusion of CPH in broiler diets was best at 20% replacement level for maize
2. Therefore, more work still need to be done in improving CPH so that birds can utilize it more efficiently.

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