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REPLACEMENT VALUE OF COCOA BEAN SHELL FOR WHEAT BRAN IN BROILER DIETS

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ABSTRACT

This study investigated the replacement value of cocoa bean shell (CBS) for wheat bran in broiler diets. Performance, economics of production and carcass characteristics were studied. The control (Diet 1) had 0% CBS while Diets 2 and 3 had wheat bran replaced by raw (untreated) and treated (boiled) CBS at 50%, respectively. Wheat bran was replaced by raw and treated CBS at 100%, respectively in Diets 4 and 5.Two hundred day-old Arbor Acre chicks were reared to one-week of age on the control starter feed. Fifty of the runts and heavy weight chicks were culled. The remaining 150 chicks were allotted to the five dietary treatments in a completely randomized design. Each treatment had 30 chicks replicated thrice. The diets were formulated as starter mash (Weeks 1- 4), and finisher mash (Weeks 5-8). Experimental duration was seven weeks during which feed and water were given *ad libitum.* At both starter and finisher phases, feed intake and weight gain were depressed ($P<0.05$) at the 100% replacement levels. Feed conversion ratio was not significantly influenced by dietary treatments in both phases. Feed cost/kg gain was 4 - 7% lower on the experimental diets in relation to control. No mortality was observed throughout the trial. There were no significant differences in dressing percentage and visceral weights and lengths. The results indicated that CBS could biologically and economically replace up to 50% wheat bran in broiler diets.

Keywords: Cocoa bean shell, replacement value for maize bran, broiler performance

INTRODUCTION

Cocoa bean shell (CBS) is the shell (testa) immediately surrounding cocoa bean. It is about 10% the weight of the bean (Emiola *et. al.*, 2011). It is an industrial by-product of cocoa processing. Nigeria presently produces over 380,000 tonnes of cocoa bean (Cadoni, 2013). The bulk of the CBS arising from local processing forms an industrial waste product until recently, contractors were paid to dispose the waste with observations that the disposal locations like streams, posed health hazards to man.

CBS has a proximate composition comparable to some other agro- allied by-products which are already being used in poultry feeds in Nigeria like wheat bran and maize bran (Menon, 1982)

Since poultry consume 70% of commercial feeds in Nigeria (Afolayan and Afolayan, 2008), it would be worthwhile to investigate the potentials of in poultry feeds.

CBS - has an intrinsic anti-nutritional factor. This is theobromine, a xanthine alkaloid like caffeine (Baer and Pinkston, 1997). The name is derived from theobroma, the genus of the cacao tree, followed by the suffix *ine* given to alkaloids (Beneth and Bealer, 2002). It is present at 1.5 - 4.0% in CBS. The ingestion of theobromine is lethal to animals beyond 0.0279 kg per body weight (Menon, 1982). Laying hens were used in five consecutive feeding trials (Olubamiwa *et*

al., 2002; 2006; 2012a, b; and Olubamiwa and Hamzat, 2006) to test the potential of cocoa bean shell in layers mash. The results they obtained showed that replacement of maize with boiled cocoa bean shell at 20% was profitably utilized in layers mash. The results subsequently led to the first commercial usage of CBS in poultry feeds in Nigeria. The managing director of a commercial feed mill, popularly known as Hope farm took part in the last of the five trials (Olubamiwa *et. al.* 2012a) which was an on-farm study. He was so convinced with the results that he subsequently procured 120,000 tonnes of CBS from Multi-Trex Integrated foods, PLC (a cocoa processing company), Warewa, Ogun state, a cocoa processing industry. The success with layers informed the present study on broilers.

Other workers have also previously studied the dietary value of CBS in poultry diets. Adeyina *et. al.* (2008) reported safe use of CBS at 10% dietary inclusion for cockerels. Olumide *et al.* (2010) reported that enzyme- (Rovabio-) treated CBS can effectively replace up to 15% maize in broiler diets. Adeyemo *et. al.* 2015 fed graded levels of bio-detheobrominised CBS in broiler diets. The results indicated that inclusion of up to 10% CBS had no adverse effect on performance.

The objective of the present study was to gradually work towards a strategy for the practical use of CBS in commercial broiler diets in Nigeria. The strategy was to test the replacement value of CBS for similar ingredients like wheat bran and maize bran in broiler diets. This departs from the previous studies that looked at dietary or maize replacement levels.

MATERIALS AND METHODS

The seven-week experiment was carried out at the Broiler Unit of Landmark University Teaching and Research Farm. Two hundred day-old chicks of the Arbor Acre breed were sourced from a commercial hatchery in Offa, Kwara State, Nigeria. The CBS for the experiment was obtained from Ile Oluji Cocoa Products Ltd., Ile Oluji, Ondo State. Some of the CBS were subjected to boiling treatment (15 mins.) according to the procedure of Olubamiwa *et. al.* (2012a). They were then sundried and milled. Other feed ingredients were purchased commercially and compounded at a feed mill in Omu Aran, Kwara State, Nigeria.

Management of experimental birds: The birds were batch brooded for the first 7 days. They were fed the common starter (control) diet during this period. The runts and extremely heavy chicks were culled in the early morning of the eight day leaving 150 birds. These were distributed 10 per replicate (three replicates per treatment) in a completely randomized design. There were five treatments (Tables 1 and 2). The treatments included the control (Diet 1; 0% CBS). Diets 2 and 3 contained untreated CBS (UCBS) and boiled CBS (BCBS), respectively at 50% replacement of wheat bran. Diets 4 and 5 contained UCBS and BCBS, respectively at 100% replacement of wheat bran. The birds were given feed and water *ad libitum* throughout the study.

At the termination of the trial at the end of the 8^{th} week, measurement of carcass parts was carried out. The blood was properly drained after slaughtering the birds. After defeathering, the weight was taken. The visceral organs were also separated and taken to the laboratory for measurement of their weight and length. Chemical and statistical analyses: The proximate, starch, sugar, and Ca and P contents of the diets were determined using the Atomic Electronic

Perten Analyzer. The machine has a plate where the sample is deposited. The machine uses light technology to analyse, and results are displayed on the monitor.

Data for all variables were analyzed using one way analysis of variance of SAS (2003). The Duncan's Multiple Range Test, was used for mean comparisons. The level of probability was $P<0.05$.

RESULTS AND DISCUSSION

The chemical composition of the test diets were similar (Table I). This is a reflection of the closeness of the ingredients making up the diets. Feed intake was depressed ($P<0.05$) at the 100% replacement level during the starter and finisher stages. The lowered feed intake at the higher (100%) CBS replacement level may be due to increased residual dietary theobromine. Similar observations have been made previously with laying hen, cockerels and Peking ducks as dietary levels of CBS increased (Yeong *et. al.*, 1989;Adeyina *et. al.,* 2008; Olubamiwa *et. al.*,2012b). Olubamiwa *et. al.* (2012b) reported that the intestinal linings of dead birds on higher dosage of CBS were destroyed. It is deduced that this adverse effect might have lowered feed intake. A possible erosion of the intestinal linings of birds on the increased CBS diets could have taken place resulting in reduced feed intake.

Weight gain was also lower ($P<0.05$) in both phases at the 100% CBS replacement levels. This may have resulted from the lower feed intake. This is in agreement with the report of Adeyemo *et. al.* (2015) who reported lower weight gain of broilers as dietary CBS increased beyond 10%. The authors suggested the likelihood of theobromine binding up essential nutrients thereby impacting their bioavailability to the birds and consequently impeding bird growth.

Feed conversion ratio (FCR) was similar across treatments in the two feeding stages. FCR gives a hint of biological utilization which could be said to be similar on the diets. The deficiency of feed utilization in an economic study like this is that it may fail to show the economic details which were indicated in the feed cost/kg gain. This was 4-7% lower on the experimental diets in relation to control. A producer handling thousands of birds would definitely opt for a diet that is 5% lower in cost if FCR remains constant among the available feeds since net income is the critical trait in the economic success of poultry production.

No mortality was observed throughout the trial. This observation was novel to the authors. A possible reason could be the culling of runts and sickly birds at a week old. Another possibility is an anecdotal report that CBS-based diets enhanced livability. Additionally, the trial was conducted in a virgin location with a possible lower predisposition to poultry diseases.

The results on the various carcass characteristics were not significantly ($P< 0.05$) different across treatments. The non-significant differences in the carcass characteristics (dressed weight, abdominal fat and visceral weights and length–Table 6) indicated that the dietary elements probably had no adverse effect at the level of inclusion.

The overall implication of the results is that CBS could biologically and economically replace up to 50% wheat bran in broiler starter and finisher diets. This will be a double gain to Nigeria's cocoa sector: contractors will no longer be paid to dispose CBS, and there would be value addition to the cocoa chain. Furthermore, our streams would be kept free from CBS disposal

removing the health hazard this poses. Concerted use of CBS in layers and broiler feeds in Nigeria would therefore be of economic and health benefits. This is more so as cocoa production and local processing would continue to experience an upsurge given what is happening on the global cocoa market. According to a most recent report (NCA Smart Brief, 2016), the major global chocolate companies are to spend $1billion to improve the output and sustainability of cocoa production.

Table I: Composition of starter diets (%)

Ingredients	Control*	50% Untreated CBS	50%Boiled CBS	100% UCBS	100% BCBS
Wheat bran	8.00	4.00	4.00	0.00	0.00
UCBS	0.00	4.00	0.00	8.00	0.00
BCBS	0.00	0.00	4.00	0.00	8.00
Common ingredients**	92.00	92.00	92.00	92.00	92.00
	100.00	100.00	100.00	100.00	100.00
Chemical analyses (%DM)					
Crude protein	21.37	22.05	22.00	22.32	22.17
Crude fat	5.47	5.51	5.47	5.36	5.44
Crude fibre	3.31	3.69	3.57	3.95	3.85
Ca	0.55	0.48	0.32	0.29	0.38
P	0.82	0.86	0.87	0.86	0.85
Calculated ME (Kcal/kg)	2812.51	2822.27	2822.27	2832.03	2832.03

*T1- Treatment

**Common ingredients: Maize (53.00); Soya bean meal (17.00); Groundnut cake (18.00); Fish meal (1.50); Oyster shell (0.80); Bone meal (0.25); Lysine (0.30); Methionine (0.45); Salt (0.25); Vitamin/Mineral Premix (0.25)

Table 2: Composition of finisher diets (%)

Ingredients	Control*	50% Untreated CBS	50% Boiled CBS	100% UCBS	100% BCBS
Wheat bran	8.00	4.00	4.00	0.00	0.00
UCBS	0.00	4.00	0.00	8.00	0.00
BCBS	0.00	0.00	4.00	0.00	8.00
Common ingredients**	92.00	92.00	92.00	92.00	92.00
	100.00	100.00	100.00	100.00	100.00
Chemical analyses (%DM)					
Crude protein	17.68	18.73	18.12	18.93	18.49
Crude fat	4.94	4.88	4.67	4.82	4.65
Crude fibre	2.75	2.83	3.30	3.28	3.18
Ca	0.54	0.58	0.48	0.55	0.49
P	0.71	0.73	0.69	0.73	0.72
Calculated ME (Kcal/kg)	2912.32	2931.08	2931.08	2940.84	2940.84

*****Treatments: T1 (Control diet), T2 (50% Untreated CBS), T3 (50% Boiled CBS), T4 (100% UCBS), T5 (100% BCBS).

**Common ingredients: maize (63.80); Soya bean meal (12.00); Groundnut cake (12.00); Fish meal (2.00); Oyster shell (0.70); Bone meal (0.25); Lysine (0.30); Methionine (0.45); Salt (0.25); Vitamin/Mineral Premix (0.25)

Table 3: Performance and economics of production of starter broilers fed CBS in replacement for wheat bran

Parameters	T1*	T2	T3	T4	T5
Daily feed intake	87.15 ±5.62^{ab}	89.30±5.68^{ab}	91.27± 5.69^{a}	83.49±5.66^{bc}	78.49±5.60^{c}
Daily weight gain	44.12±4.23^{a}	46.10±4.23^{a}	45.53±4.23^{a}	38.91±4.11^{b}	37.21±4.10^{b}
FCR	1.97±0.15^{ab}	1.92±0.15^{b}	2.04±0.16^{ab}	2.21±0.16^{a}	2.14±0.16^{ab}
Mortality	0.00	0.00	0.00	0.00	0.00
Feed cost/kg(₦)	86.90	86.10	86.10	85.20	85.40
Feed cost/kg Weight gain(₦)	171.20	165.30	175.60	188.30	182.80

FCR - Feed conversion ratio

Means with different superscripts within the same row are significantly ($P<0.05$) different

*****Treatments: T1(Control diet), T2 (50% Untreated CBS), T3 (50% Boiled CBS), T4 (100% UCBS), T5 (100% BCBS).

Table 4: Performance and economics of production of finisher broilers fed CBS in replacement for wheat bran

Parameters	T1*	T2	T3	T4	T5
Daily feed intake	178.53 ±8.13^{a}	177.99±8.13^{a}	178.00± 8.13^{a}	160.65±8.00^{c}	168.67±8.10^{b}
Daily weight gain	74.42±4.42^{abc}	76.02±4.42^{ab}	79.49±4.46^{a}	68.96±4.40^{c}	72.36±4.42^{bc}
FCR	2.42±0.06^{a}	2.37±0.05^{a}	2.35±0.05^{a}	2.37±0.05^{a}	2.33±0.05^{a}
Mortality	0.00	0.00	0.00	0.00	0.00
Feed cost/kg(₦)	79.90	78.40	78.50	77.00	77.00
Feed cost/kg					
Weight gain(₦)	193.40	185.80	184.50	182.50	179.60

FCR Feed conversion ratio
Means with different superscripts within the same row are significantly (P<0.05) different
*****Treatments: T1(Control diet), T2 (50%UntreatedCBS), T3 (50% Boiled CBS), T4 (100% UCBS), T5 (100% BCBS).

Table 5: Carcass characteristics and organ weights of broiler birds fed cocoa bean shell in replacement for wheat bran

Parameters	T1* (Control)	T2	T3	T4	T5	SEM
Live weight (g)	2840.00	2930.00	2860.00	2730.00	2990.00	40.00
Dressed weight(g)	2120.00	2320.00	2190.00	2130.00	2230.00	30.00
Visceral weight (g)	300.00	290.00	290.00	280.00	310.00	7.00
Abdominal fat (g)	43.98	39.59	44.52	50.16	62.09	4.48
Gizzard length (cm)	10.42	10.75	10.42	10.42	10.18	0.21
Gizzard weight (g)	54.74^{a}	48.88^{ab}	45.05^{ab}	40.73^{b}	45.89^{ab}	1.70
Intestinal length (cm)	229.70^{ab}	250.92^{a}	216.50^{b}	218.97^{b}	233.89^{ab}	4.74
Intestinal weight (g)	67.61	70.54	74.95	66.43	66.17	2.30

*****Treatments: T1 (Control diet), T2 (50% Untreated CBS), T3 (50% Boiled CBS), T4 (100% UCBS), T5 (100% BCBS).
Means with different superscripts within the same row are significantly (P<0.05) different

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