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Effect of Boiling Time on the Utilization of Cocoa Bean Shell in Laying Hen Feeds

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Abstract: Efficient utilization of cocoa by-products has been identified as one of the means of ensuring the sustainability of the cocoa economy. A series of studies was started in 2000 with the aim of finding commercial usage for cocoa bean shell (CBS) in poultry (layer) diets. In the first trial, CBS was fed raw at graded levels (0, 10, 20, 30 and 40%) of maize replacement in layers mash. Suffice it to mention that maize constitutes > 50% of most layer feeds. The 10% diet was significantly better (P<0.05) utilized than others. The second study assessed variously treated CBS at the 10% level. The boiled and urea-treated CBS based rations were better (P<0.05) utilized than others. The third trial, which used 20% dietary maize replacement by CBS, established the boiled (30-minutes) CBS to be superior (P<0.05) to the urea-treated. The present investigation assessed the optimal boiling time for CBS among durations of 15, 30, 45 and 60 minutes. The 10-week experiment used one hundred and sixty-eight 32-weeks old laying hens. These were randomly allotted to the 7 treatments, which included 0% CBS diet, a commercial diet and an untreated CBS diet. The rest diets contained CBS boiled for 15, 20, 45 and 60 minutes. Maize was replaced at 20% level in the control mash in all the CBS based mashes. Among the CBS diets, only the 15-minutes boiled batch supported similar egg production and feed conversion as the Control diet. Feed intake and egg quality parameters were equal across treatments. Feed cost/kg egg was least on the 15-minutes boiled CBS diet.The results of this experiment indicated very strongly that the 15-minutes boiling duration is the best for optimal and profitable utilization of CBS in layers mash.

Key words: Cocoa bean shell, boiling treatment duration, layers performance, economics of production

Introduction

Cocoa bean shell (CBS) is a waste product from chocolate and cocoa milling industries. It is the thin husk immediately surrounding the cocoa bean. Gohl (1981) observed that CBS is high in nutritive value but it is of limited use in animal feeds because of its theobromine content. Theobromine belongs to the same naturally occurring methylated xanthine group as caffeine (Ching and Wong, 1986). When taken in modest quantities, it acts as a stimulant like caffeine but intake of more than 0.0279 kg per body weight is injurious to animals (Menon, 1982).

Hutagalung and Chang (1978) observed that the amino acid profile of CBS compares favourably with palm kernel cake suggesting that it could be utilized as a medium protein source to substitute grain protein in livestock diets. A previous study (Olubamiwa *et al*., 2001) has shown that higher dietary replacement of maize by CBS beyond 10% resulted in lower performance of layers. This limited use of CBS in animal feed had always been blamed on its theobromine content (Olubamiwa *et al*., 2001; Olubamiwa *et al*., 2002; Olubamiwa and Hamzat, 2005). Menon (1982) indicated that the anti-nutritional compound could be reduced by heat, sun drying and boiling.

Previous studies have been carried out to find the best processing technique for detheobrominising CBS for feeding laying hens. It was reported that boiling technique was most efficient in detheobrominising CBS (Olubamiwa and Hamzat, 2005). However, that study used only 30 minutes boiling time. The present study focused on the effect of different boiling durations on CBS. This was with the aim of establishing the best boiling duration (nutritionally and economically) for the utilization of CBS in laying hen feeds.

Table 1: Proximate composition of test ingredients (CBS) (%)

Component	U	T15	T30	T45	T60
Dry matter	84.95	85.63	86.08	86.29	85.63
Crude protein	6.78	14.00	13.89	13.78	12.47
Crude fibre	33.00	25.00	40.00	37.40	37.00
Ether extract	13.00	11.00	12.00	12.00	12.00
Ash	9.00	8.00	7.30	8.00	15.50
Nitrogen free extract	23.17	27.63	12.69	15.51	8.66
Theobromine	0.55	0.46	0.43	0.39	0.29

CBS- Cocoa bean shell. U-Untreated CBS; T15-15 mins boiled CBS; T30-30 mins boiled CBS; T45-45 mins boiled CBS; T60-60 mins boiled

Materials and Methods

Diets: Seven experimental diets were used. These included the control (0% CBS) and a commercial diet. The latter was selected as a result of its high patronage in Ibadan metropolis. This was to allow for adequate comparison. Five CBS-based diets included untreated CBS and boiled CBS for 15, 30, 45, and 60 minutes.

Table 2: Gross composition of experimental diets (%)

Ingredient	C	T0	T15	T30	T45	T60	Comm
Maize	58.00	46.40	46.40	46.40	46.40	46.40	
Cocoa bean shell	-	11.60	11.60	11.60	11.60	11.60	
Soya bean meal	10.00	10.00	10.00	10.00	10.00	10.00	
Groundnut cake	8.00	8.00	8.00	8.00	8.00	8.00	
Fish meal	2.00	2.00	2.00	2.00	2.00	2.00	
Wheat bran	5.00	5.00	5.00	5.00	5.00	5.00	
Malt dust	6.00	6.00	6.00	6.00	6.00	6.00	
Oyster shell	8.00	8.00	8.00	8.00	8.00	8.00	
Bone meal	2.30	2.30	2.30	2.30	2.30	2.30	
Layer premix	0.25	0.25	0.25	0.25	0.25	0.25	
Methionine	0.15	0.15	0.15	0.15	0.15	0.15	
Lysine	0.15	0.15	0.15	0.15	0.15	0.15	
Salt(NaCl)	0.15	0.15	0.15	0.15	0.15	0.15	
Total	100.00	100.00	100.00	100.00	100.00	100.00	
Calculated analysis (%)							
Crude protein	18.97	19.08	20.13	19.36	19.69	18.60	19.69
Crude fibre	14.00	10.00	8.00	10.00	10.00	10.00	9.00
Theobromine	-	0.08	0.08	0.07	0.05	0.05	-

CBS: Cocoa bean shell. C: Control CBS diet. TO: Untreated CBS diet. T15, T30, T45, T60, - 15,30, 45 and 60 mins treated CBS based diets. Comm: Commercial diet.

Maize was replaced with CBS at 20% level in all the CBS based diets.

Birds and their management: A total of one hundred and sixty-eight 32 - weeks old layers were used for the experiment. The birds were housed in battery cages equipped with feeding troughs and water drinkers. They were fed two times daily (8.00-8.30 a.m.) and in the afternoon (2.00-2.30 p.m.). Water was provided *ad libitum*.

Experimental design and data collection: The birds were randomly distributed into seven treatments. Each treatment had three replicates, with eight birds per replicate. The experimental design was completely randomized design (CRD). The number of eggs in each replicate was recorded daily and summed up at the end of the week to obtain weekly egg production. Percent hen-day production was calculated as number of eggs laid divided by number of days according to the procedure of Oluyemi and Roberts (1981). Feed conversion ratio (FCR) was calculated as feed consumed divided by egg weight.

Egg quality determination: Eggs from each replicate were sampled for quality characteristics. Egg length and width were measured with venier caliper. Egg shape index was calculated as egg width divided by egg length. Shell weight was taken after cleaning out the adhering albumen. Haugh unit was calculated from egg weight and albumen height using the formula: HU- 100 log (H+7.57-1.7 w) where H is albumen height in millimeters and w is weight of egg. The albumen height was obtained by dipping a thin broomstick into the center of the albumen placed on a slide. The observed height was measured against a ruler graduated in millimeters. The Haugh Unit developed by Haugh (1937) is the measure most commonly used in assessing internal quality of eggs.

Statistical analysis: The data were analyzed using the analysis of variance (ANOVA) and Duncan's Multiple Range Test was used to separate the means using statistical analysis system, SAS (1995) package.

Results and Discussion

The chemical components of the diets and the test ingredients are shown in Table 1 and 2.

The data on theobromine content of CBS showed that the period of boiling influenced theobromine content. As boiling time increased, theobromine content reduced. This result corroborated the findings of Olubamiwa *et al.* (2002) that boiling was effective in eliminating theobromine.

The 15 - minutes boiled CBS was the only CBS diet that compared favourably with the control diet in hen-day egg production. Additionally, it showed a better-feed conversion ratio than all other diets except the control. The low crude fibre content of the diet may have contributed to this since high dietary crude fibre is reported to reduce poultry feed conversion (Yu *et al.*, 1998). The similarity of egg quality parameters (shell weight, haugh unit, egg shape index) across treatments is a good indication that CBS has no deleterious effect on egg quality. Shell thickness (strength) has been related to the percentage of broken eggs (Abdallah *et al.*, 1993), which is of economic importance. An excellent alternative measurement of eggshell thickness is the eggshell percentage (Abdallah *et al.*, 1993) an equivalent of the weight. Therefore, similar shell weight across treatments in this study apparently indicated similar shell strength.

Table 3: Performance and egg quality of laying hens fed CBS- based diets

Parameter	C*	U	T15	T30	T45	T60	Comm	SEM
Feed intake (g/b/d)	102.30	99.84	101.97	102.28	100.05	102.68	106.44	0.826
Hen day	74.34^{a}	64.97^{bc}	70.00^{ab}	65.31^{bc}	62.71^{c}	64.99^{bc}	68.37^{abc}	1.493
Production (%)								
Egg weight (g)	55.85^{a}	52.03^{c}	55.56^{a}	55.97^{a}	55.54^{a}	56.19^{a}	54.32^{b}	0.555
Feed conversion	2.49^{c}	3.05^{a}	2.71^{bc}	2.92^{ab}	3.00^{ab}	2.92^{ab}	2.92^{ab}	0.073
N/kg egg	94.00	99.00	88.00	94.00	97.00	95.00	96.00	ND
Shell weight (g)	8.55	8.73	8.84	8.08	8.67	8.16	8.07	0.125
Egg shape	0.79	0.78	0.79	0.79	0.79	0.78	0.80	0.002
Index								
Haugh unit	85.24	84.87	82.12	80.70	79.88	84.04	82.50	0.776

CBS-Cocoa bean shell. C-Control diet. T15, T30, T45, T60 - 15, 30, 45, and 60mins. Treated CBS-based diets. Comm-Commercial diet. ND- not determined

A most interesting observation of this study has to do with data on the feed cost per kg egg. Much as feed conversion is a good indicator of biological efficiency, it may not speak much about the economic performance of a diet (Olubamiwa *et al.,* 2000). Poultry production is business hence the most critical factors are those that cogently point at the economic returns. This is where the cost of feed per egg laid becomes very important. It is the single most important factor in this study because it points at the economic returns to the proprietor. The 15-minutes boiled CBS diet was superior to all others including the control in this regard. This is a striking indication of the invaluableness of this CBS sample. As per the objectives of this study, the 15-minutes boiling duration is the best for detheobrominising CBS both nutritionally and economically for poultry diets. Consequently, efforts to simulate the result of this treatment on industrial basis should take note of this boiling time.

Conclusion: This study has indicated that the inclusion of 15-minutes boiled CBS at 20 % maize replacement in layers mash is profitable. Prior to industrial application of the results of the study, it is suggested that on-farm trials be undertaken. Despite the obvious potential, the use of non-conventional feeding-stuffs particularly in the developing countries where they are mostly needed has been negligible partly from a lack of studies under small farm conditions (Ravidran, 1995). In fact, small farms have been identified as the best clients of agricultural research in developing countries (Anonymous, 1997).

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