RESPONSE OF LAYING CHICKENS FED GRADED LEVELS OF COCOA POD-AND-HUSK MEAL

S. A. Osei, M.Sc., Ph.D
P.K.Sarpong, B.Sc.
Department of Animal Science, University of Science and Technology, Kumasi
D.Adomako, M.Sc., Ph.D.
E.B.Frimpong, M.Sc., Ph.D.
Cocoa Research Institute of Ghana, Tafo, Ghana

ABSTRACT

The responses of 192 ready-to-lay chickens (20 wk old) were studied in an 8-month long experiment in which graded levels of cocoa pod-and-husk (CPH) meal were fed. Four dietary treatments incorporating 0, 50, 100 and 150g of CPH meal per kg were used and the birds were randomly assigned in equal numbers in a completely randomised design. The diets were isocaloric and isonitrogenous and were fed ad libitum. Water was also provided free choice.

While feed consumption significantly increased as dietary CPH levels increased, the efficiency of feed conversion, final body weight and weight gain declined ($P < 0.05$). None of the other production traits were influenced by CPH level. In addition CPH had no significant effect on blood parameters including haemoglobin, PCV, total protein, globulin and albumin.

The feeding of CPH significantly increased the weight of kidneys, gizzard and intestines.

KEYWORDS: *Cocoa, pod, husk, layers, performance.*

INTRODUCTION

Cocoa pod-and-husk (CPH) has been investigated as a potential unconventional feedstuff for poultry [1, 2, 3, 4]. CPH however contains the toxic alkaloid, theobromine, which according to Clarke *et al*[5] is completely absorbed from the digestive tract and is only slowly excreted; consequently small doses may have cumulative effects, including sudden death from heart failure.

While the published data [1, 2, 3, 4] indicated that CPH up to 200g/kg diet has no deleterious effects on performance most investigations lasted only eight to twelve weeks, a time span that does not allow a full study of the cumulative effects which are exerted over a long time. This work was therefore undertaken to establish the long term effects of CPH on the performance of laying chickens.

MATERIALS AND METHODS

The cocoa pod-and-husk (CPH) meal used in the study was obtained from the Cocoa Research Institute of Ghana at Tafo as previously described[6]. The proximate and nutrient composition of CPH has been provided by Donkoh *et al*[4].

One hundred and ninety-two AF Bosbek brown laying fowls at 20 wk of age and averaging 3% hen-day production were randomly allotted in equal numbers to four dietary treatments incorporating 0, 50, 100, and 150g CPH meal per kg respectively (Table 1). Each treatment was replicated thrice. The fowls averaged 1.52kg liveweight and were transferred from a deep litter house into metal cages that provided 0.14m^2 space/bird. Food and water were supplied ad libitum. Data were collected for eight months on hen-day production, yolk colour score, egg shell thickness, egg weight, yolk colour score, egg shell thickness, Haugh unit score and egg specific gravity. Hen-day production was calculated daily and averaged for each month while egg weights, yolk colour score, egg shell thickness, Haugh unit score and egg specific gravity were determined once every 14 days. Egg yolk score was determined by visual comparison of the fresh yolk with the different colours of the Roche colour fan; egg shell thickness was measured with the aid of the Ames thickness measure at the equatorial plane of the egg after removal of the shell membranes. Haugh unit scores were measured with an egg quality slide rule (The Kaw Company, Trenton, New Jersey) and egg specific gravity using the Archimedes' principle.

Prof. S. A. Osei

Mr. P.K. Sarpong

Dr. D. Adomako

Dr. E.B. Frimpong

TABLE 1: COMPOSITION AND ANALYSIS OF EXPERIMENTAL DIETS.

Ingredients	Level of dietary CPH meal (g/kg) 0	50	100	150
CPH meal	-	50	100	150
Fishmeal	125	130	130	130
Maize meal	550	550	550	550
Wheat bran meal	180	110	55	9.7
Brewer's spent grain	55	70	75	70
Oyster shell	82.5	82.5	82.5	82.8
Sodium chloride	2.5	2.5	2.5	2.5
Premix[1]	5	5	5	5
Calculated analysis (g/kg DM, except ME)				
Crude protein	168.9	168.1	166.4	163.2
Crude fibre	40.0	52.2	64.2	76.1
Ether extract	40.5	40.8	40.9	40.5
Calcium	38.2	38.4	38.6	38.5
Available phosphorus	5.8	5.8	5.7	5.6
Lysine	8.6	8.6	8.5	8.5
Methionine	3.9	3.8	3.8	3.7
Cystine	2.6	2.5	2.4	2.3
ME (MJ/kg)	11.04	11.03	11.00	10.92
Analyzed Composition (g/kg DM)				
Crude protein	166.5	159.6	158.3	165.2
Ether extract	20.8	29.1	30.9	33.7
Crude fibre	41.8	55.9	61.1	74.9
Ash	132.2	131.2	128.5	131.0
Dry matter	886.6	871.2	875.6	864.2

[1]Premix provided per kg diet: Vitamin A, 17.8mg; D, 1600IU; E, 20mg; ribo-flavin, 12.5mg; pantothenic acid, 25mg; K, 5mg; nicotinic acid, 250mg; choline chloride, 2500mg; iron (Fe), 100mg; cobalt, 2mg; zinc, 75mg and iodine, 2.5mg.

All blood parameters were measured at 14-day intervals. Blood samples (5 ml each) were drawn from the wing vein of three birds randomly selected from each replicate into EDTA-containing vacutainer tubes and stored on ice until analyzed. Haemoglobin and packed cell volume (PCV) were measured by the cyan-methaemoglobin and micro-haematocrit methods respectively[7] using whole blood. The remaining blood parameters were determined using serum according to procedures cited by Varley[8].

Other measurements were food consumption, body weight gain and efficiency of food utilisation. In addition, weights of certain digestive and metabolic organs were determined at the termination of the experiment (Table 4)

RESULTS

The results of the effects of CPH on live performance are shown in Table 2. The addition of CPH to the diets resulted in a significant linear depression ($P < 0.05$) in final body weight of the layers. Average weekly feed consumption increased from 3.15 kg/bird on the control diet to 3.24 kg/bird on the highest level of dietary CPH and the differences were statistically significant ($P < 0.05$). There were no significant dietary CPH effects on hen-day egg production (which ranged from 59.6 to 60.3%) or egg quality parameters (egg weight, yolk colour score, egg shell thickness, Haugh unit score and egg specific gravity). However, layers on the highest level of dietary CPH laid at a lower rate in the first two months before catching up with the other groups in the third month of lay. The ability of layers to convert CPH diets to eggs however progressively declined ($P < 0.05$) as CPH levels in the diet increased and reached significance at the maximum level of CPH inclusion in the diets. The feeding of CPH significantly increased layer mortality ($P < 0.05$). Thirty birds in all died made up of 4, 7, 8, and 12 respectively from the 0, 50, 100 and 150g CPH/kg diets. Post-mortem examination however indicated no specific causes of

TABLE 2: EFFECTS OF CPH MEAL ON GROWTH, FEED CONSUMPTION AND EGG PRODUCTION

Variable	Level of dietary CPH meal (g/kg) 0	50	100	150	Overall SEM[1]
Mean initial body weight (kg)	1.52	1.52	1.52	1.52	-
Mean final body weight (kg)	1.90	1.85	1.75	1.70	0.05**
Mean body weight gain (kg)	0.38	0.33	0.23	0.18	0.05**
Mean food consumption (kg)	3.15	3.25	3.27	3.24	0.03**
Hen-day egg production (%)	58.4	59.0	59.6	57.6	0.43
Mean egg weight (g)	59.7	60.3	59.7	59.6	0.16
Yolk colour score	1.3	1.3	1.3	1.3	-
Egg shell thickness (mm)	0.34	0.35	0.35	0.35	0.02
Haugh unit score	80.3	82.1	82.7	80.4	0.60
Egg specific gravity	1.08	1.08	1.09	1.09	-
Food : egg	2.81	2.88	2.88	2.98	0.03**
Mortality (%)	8.3	14.6	16.7	25.0	-**

[1]SEM = Standard error of mean

**Significant difference at P < 0.05.

TABLE 3: EFFECTS OF CPH MEAL ON BLOOD VARIABLES

Variable	Level of dietary CPH meal (g/kg)				
	0	50	100	150	Overall SEM[1,2]
Haemoglobin (g/dl)	9.6	9.4	9.9	9.6	0.25
Packed cell volume (%)	25.0	23.9	25.1	25.0	0.29
Total protein (g/l)	55.1	61.8	59.0	59.3	1.38
Albumin (g/l)	16.2	19.6	16.7	17.3	0.76
Globulin (g/l)	38.9	42.1	42.3	42.0	0.81
Albumin : globulin	0.6	0.6	0.5	0.5	-

[1]SEM = *Standard error of mean.*
[2]*Differences in means non-significant* ($P < 0.05$).

death although there were signs of salmonella infection.

The effects of CPH on blood parameters are presented in Table 3 above. Dietary CPH had no significant effect on any of the blood variables studied.

Cocoa pod-and-husk meal had no significant influence on the weights of liver, heart and proventriculus although liver and proventriculus weights tended to increase as CPH levels increased (Table 4). Kidney weights significantly increased with increasing levels of CPH in the diets ($P < 0.05$). Increasing levels of CPH in the diets significantly increased the weights of gizzards (full) and intestines (both full and empty). Crop weight changes were inconsistent.

DISCUSSION

The significant linear depression in growth as well as in body weight gains agrees with earlier reports with broilers[1,10] and has been attributed to several factors such as the increasing crude fibre levels in the diets as CPH increased which would result in a decrease in the digestibility of protein, energy and other nutrients[11] while possible imbalances in amino acids, minerals and other nutrients have been suggested[1].

TABLE 4: EFFECTS OF CPH MEAL ON ORGAN WEIGHTS (G/KG LIVEWEIGHT) IN LAYING CHICKENS

Variable	Level of dietary CPH meal (g/kg)				Overall
	0	50	100	150	SEM[1]
Liver	19.7	20.4	21.6	21.8	1.04
Kidney	3.0	3.2	3.6	3.7	0.10**
Heart	3.4	3.5	3.4	3.4	0.06
Full crop	22.9	28.1	24.6	29.5	4.07
Empty crop	3.3	3.8	4.5	3.8	0.22
Full proventriculus	3.8	4.3	4.3	4.3	0.09
Empty proventriculus	3.3	4.2	3.6	3.2	0.24
Full gizzard	24.5	24.1	28.1	29.2	0.87**
Empty gizzard	12.7	13.9	15.4	16.7	0.61**
Small intestines					
Full	41.7	49.5	51.5	54.2	1.94**
Empty	19.1	23.0	24.1	26.2	0.98**

[1]SEM = *Standard error of mean.*
***Significant linear effects of CPH meal* ($P < 0.05$).

The significant increases in food consumption by broilers on CPH diets corroborate earlier observations[4] which showed a 58.3 per cent increase in feed consumption in broilers when the dietary metabolisable energy (ME) was reduced from 11.7 to 10.7 MJ/kg with addition of 200g CPH/kg diet. As CPH levels increased in the diets ME declined from 11.04 MJ/kg to 10.92 MJ/kg in this experiment. Chicken are monogastric animals and eat to satisfy their energy requirements. They thus consume more of low-energy diets, in this case, the CPH diets[4].

Dietary CPH meal had no significant effect on egg production, a finding similarly previously reported in Nigeria and Ghana[1,6]. The initial slower rate of lay of layers on the 150g CPH/kg agrees with data reported from Nigeria[10] which showed that such high levels of CPH delayed the onset of laying in pullets. The absence of a significant effect of CPH meal on egg weight, yolk colour score, egg shell thickness and egg specific gravity confirm earlier data [6,14].

While readily consuming diets incorporating CPH meal, layers were on the other hand incapable of efficiently converting such diets to eggs (or for growth) compared with layers on the control diet. As earlier explained, this might be due to the high crude fibre content of CPH diets leading to impaired nutrient digestibility, particularly of amino acids and also to nutrient imbalances[1,11].

The increased mortality attributable to the feeding of CPH is difficult to explain. Clarke *et al*[5] have stated that deaths from theobromine poisoning involve, among other things, a sudden heart attack. No signs of heart disease were evident on post-mortem, however. There was evidence to suggest, on the other hand, salmonella infection in eight cases of mortality and this may indicate contamination of the stored CPH.

The response of blood variables to dietary CPH meal is in accord with previous data[6,14]. The lack of effect of CPH on liver and heart weight has been similarly observed in broilers and weanling rats[3,13]. The proventriculus is a small portion of the gastro-intestinal tract of the chicken with little digestive or storage function. A lack of effect of CPH on the organ is therefore not surprising.

The increases in weight of the small intestine may be due to the increasing fibre content of CPH diets[15,16]. It has been suggested that such increases may arise from a combination of muscular hypertrophy, increased growth of mucosa and residual chyme[17].

The results of this study suggest that CPH can be incorporated in layer diets up to 150 g/kg without affecting laying performance. There is however the need to investigate more fully the mortalities that may be associated with CPH feeding.

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