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RESPONSE OF BROILER CHICKS TO DIETS CONTAINING GRADED LEVELS OF CLAY

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ABSTRACT

A total of 360 two weeks old broiler chicks were used to investigate the effect of varying dietary levels of clay on growth performance of broiler chicks. The birds were randomly divided into six groups of 60 birds each and the groups were randomly assigned to six diets containing six levels (0, 1, 2, 3, 4 and 5%) of clay. Each treatment was replicated two times with 30 birds per replicate. The study lasted for four weeks. The response parameters studied were body weight, feed intake, body weight gain, feed conversion ratio and protein efficiency ratio. Results showed that dietary clay inclusion significantly ($P<0.05$) improved weight gain and efficiency of feed utilization. There was significant ($P<0.05$) reduction in feed cost per kg weight gain and overall cost of production. The results indicated that up to 5% clay may be included in the diet of broiler chicks to enhance growth performance and to reduce the cost of production.

Key words: Arbor Acre, feed conversion ratio, feed intake, growth performance.

INTRODUCTION

The importance of feed in livestock production cannot be overemphasized as it supplies livestock with nutrients necessary for their body functions as well as for the yield of valuable products. Natural feeds could contain non – nutritional contaminants, that may reduce their nutritional value or even exert adverse health effect on animals (Fink-Gremmels, 2004). Fungal contamination affects both the organoleptic characteristics and the alimentary value of feeds and thus poses a risk of toxicosis to animals that consume them. Moulds utilize readily available and vital nutrients in the materials they grow upon and spoilage may result in the loss of 5 to 100% of the nutrients in the feed (EC, 2009). Such contamination is widespread, especially in tropical countries where high ambient temperature and humidity as well as poor sanitary and processing technology favour the survival, multiplication, spread, infectivity and pathogenicity of these organisms.

Poultry are highly susceptible to mycotoxins such as aflatoxins (Denli and Okan, 2004; Mabbett, 2004; Magnoli *et al*., 2011). Mycotoxins have negative effects on feed intake and animal performance. Their presence in edible animal products such as milk, meat and egg may have detrimental effects on human health too. Mycotoxins have been shown to be carcinogenic, immunogenic, tremorgenic (cause tremor or excitation of the central nervous system), teratogenic, hepatotoxic and also cause damage to the kidney (Ratcliff, 2002). Currently, mycotoxin binders such as clay minerals, aluminosilicates, esterifieid glucomannan and modified mannoligosaccharides have received ample scientific and industrial attention as effective tools for the elimination of mycotoxins from feeds. The use of clay supplements in the manufacture of livestock and poultry feeds is well established. Dietary clay supplements (bentonites and kaolinite) have been used as binding and lubricating agents in the production of pelleted feeds for chickens (Owen *et al*., 2012). Recent studies have shown that the addition of hydrated sodium calcium aluminium silicate (HSCAS) and bentonite clays to corn decreased the effect of aflatoxin when fed to swine. These compounds work probably by nonspecific binding to the mycotoxin and reduction of the passage time through the gut. The effect of toxins in broiler feeds can therefore be reduced to a minimal level by the manipulation of macro and micro nutrients and inclusion of clay toxin binders. However these commercial clays are hardly available to rural farmers in Nigeria. Locally available clay could serve similar purposes especially in rural poultry production where the environment favour mould infectivity and the presence of mycotoxins may not be readily detected by the farmer. Against this backdrop, the present study was conducted to investigate the effect of diets containing graded levels of local clay on growth performance of broiler chicks.

MATERIALS AND METHODS

The study was carried out at the Department of Animal Science Teaching and Research Farm, University of Nigeria, Nsukka. The experiment lasted for four weeks.

Formulation of Experimental Diets: Six (6) starter diets were formulated to contain 0, 1%, 2%, 3%, 4% and 5%

levels of clay, respectively. The ingredients and chemical composition of the diets is shown in Table 1.

Experimental Birds and Experimental Design: A total of 360 two weeks old broiler chicks (Arbor Acre strain) with initial body weight of 217 - 233 g were used for the study. The birds were randomly divided into six treatment groups of 60 birds each in a completely randomized design (CRD). Each treatment was replicated 2 times with 30 birds per replicate and housed in 4.6m x 6.4m deep litter pens (0.98m^2/bird) with fresh wood shavings to cover the floor.

The birds were properly vaccinated as and when due following the vaccination protocol for broiler birds by the National Veterinary Research Institute (NVRI), Vom, Plateau State, Nigeria (unpublished). Anti-coccidial drugs were also administered at intervals to prevent the outbreak of coccidiosis in the birds. Feed and water were offered *ad libitum* and fresh every morning, between 07:00 and 08:00 hrs. The weight of feed offered minus the weight of left over feed was recorded as the daily feed intake. The birds were weighed at the beginning of the experiment to determine their initial body weights, and subsequently on weekly basis to determine their live body weights. Feed conversion ratio was then calculated from these data as gram feed consumed per gram weight gained over the same period.

Proximate composition of feed and Statistical Analysis of data: Experimental diets were subjected to proximate analysis according to AOAC (2006). The chemical composition of the clay sample was determined at the Soil Science Departmental Teaching Laboratory, University of Nigeria, Nsukka, Nigeria. Experimental data were subjected to analysis of variance (ANOVA) for CRD using SPSS (2007). Significantly different means were separated using the Duncan option of SPSS (2007).

RESULTS

Data on the growth response of the broiler chicks to the experimental diets are shown in Table 4. The effect of treatment on final body weight and daily weight gain were significant ($P<0.05$). Birds fed 5% clay diet had significantly ($P<0.05$) higher final body weight than those fed other diets. Broilers fed the control diet (0 % clay) and those of 1 and 2 % clay were similar in final body weight while those on 3 and 4 % clay had the least ($P<0.05$) growth performance. The same trend was observed for average daily weight gain. Broilers on 5 % clay consumed significantly ($P < 0.01$) higher amount of average daily feed than those fed other diets. These were followed by those of the control (no clay), 1 and 2 % clay. Again birds on 3 and 4 % clay consumed the least amount of feed per day. Feed conversion ratio, daily protein intake and protein efficiency did not differ significantly ($P < 0.05$) between treatments.

Cost Implication of Feeding Varying Dietary Levels of Clay to Broiler Starter Birds. Dietary treatments had significant effect on the cost of feed per kg weight gain ($P<0.05$; Table 4). Birds fed 0, 4 and 5 % clay had the highest feed cost per kg gain in body weight. The least feed cost per kg gain was observed with 2 % dietary clay. Birds on 5 % clay equally had the highest total cost of feed consumed over the experimental period followed by those of the control and 4 % clay supplementation. Birds fed 1, 2 and 3 % clay recorded the least total cost of feed consumed. The above trend was repeated for cost of daily feed intake. However, broilers on 5% clay had overall highest cost of daily feed intake ($P \leq 0.05$).

DISCUSSION

Growth Performance of Broiler Chicks Fed Diets Containing Graded Levels of Clay: The significantly higher growth performance (final body weight and average daily weight gain) observed for birds fed 5 % dietary clay compared to those on other diets and the similarity between birds in the control and those of other treatments in these traits suggest that inclusion of clay in the diet improved the performance of the birds. Previous reports on growth performance of broilers fed varying levels of dietary clay agree considerably with the findings of the present study. Nasir and Haq (2001) fed sodium bentonite to broilers at 0-4 % levels and reported improved average weight gain at 1% supplementation. Eser *et al*. (2012) reported improved body weight and overall weight gain in broilers fed Sepiolite clay. The significantly higher feed intake by broiler chicks fed 5 % clay could result from the higher rate of growth. Animals feed in proportion to their body weight and general metabolic requirement which increases with growth rate. The need for more nutrients caused by nutrient dilution with higher levels of clay may have also contributed to the significant increase in feed intake by birds in this group. As such, the birds had to consume more feed in order to meet their basic dietary needs. Nasir and Haq (2001) reported a similar association between improved growth rate and feed intake. Feed intake was depressed under 2 to 4 % inclusion of clay. These birds also had the least growth performance. Acosta *et al*. (2005) reported that the addition of 1% zeolite in diet of broilers decreased feed intake while Eser *et al*. (2012) found no apparent relationship between doses of Sepiolite and feed intake in broilers. Feed conversion ration (FCR) was not significantly influenced by clay supplementation which agrees with the findings of Nasir and Haq (2001), Damiri *et al*. (2010) and Eser *et al*. (2012). However, Pasha *et al*. (2008) and Katouli *et al*. (2010) reported significant effect of bentonite, kaolin and zeolite on the FCR of broiler chicks. Katouli *et al*. (2010) reported that FCR of birds fed 3 % Kaolin in their 1st and 2nd weeks of life and 3 % zeolite in their 1st week differed significantly ($P <$

0.05) from the control. The superiority of birds fed 5 % clay diet over the control group in body weight gain and the similarity of the control group to other treatment groups in this trait and in feed conversion ratio indicate that clay treated groups (especially at 1 and 2 %) yielded more value of output per unit value of feed consumed.

Table 1. Ingredient and chemical composition of starter diets

	Diets					
Clay levels (%)	0	1	2	3	4	5
Ingredients/Treatment	A	B	C	D	E	F
Maize	45.00	44.00	43.00	42.00	41.00	40.00
Wheat offal	6.00	6.00	6.00	6.00	6.00	6.00
Groundnut cake	24.00	24.00	25.00	25.00	26.00	30.00
Soybean meal	13.00	13.00	13.00	13.00	13.00	13.00
Palm kernel cake	6.00	6.00	6.00	6.00	6.00	6.00
Fishmeal	2.00	2.00	2.00	2.00	2.00	2.00
Clay	-	1.00	2.00	3.00	4.00	5.00
Salt	0.20	0.20	0.20	0.20	0.20	0.20
Bone meal	2.80	2.80	2.80	2.80	2.80	2.80
*Vitamin/min. premix	0.20	0.20	0.20	0.20	0.20	0.20
Lysine	0.20	0.20	0.20	0.20	0.20	0.20
Methionine	0.20	0.20	0.20	0.20	0.20	0.20
Calculated composition						
Crude protein (%)	24.20	24.10	24.00	23.90	23.80	23.70
Energy (Kcal/Kg ME)	2828	2794	2759	2725	2691	2657
Fibre	4.75	4.73	4.70	4.68	4.65	4.63
Cost of feed/Kg (₦)	82.12	81.40	80.68	79.96	79.24	78.52
Proximate composition						
Dry matter	95.00	95.00	95.00	95.00	90.00	95.00
Crude protein	24.16	24.09	24.00	23.68	23.68	23.58
Ether extract	5.00	5.00	5.00	5.00	5.00	5.00
Ash	15.00	10.00	15.00	15.00	15.00	10.00
Crude fibre	4.55	5.75	5.75	5.30	5.00	4.05
Nitrogen free extract	46.29	50.16	45.25	45.80	41.32	52.37

*Vit. A : 10,000.00iu., D_3: 2,000 iu., B_1: 0.75g, $B_{2:}$ 5g, Nicotinic acid: 25g., Calcium pantothenate 12.5g., B_12-0.015g., K_3-2.5g., E-25g., Biotin – 0.050g., Folic acid –1g., Manganese 64g., Choline chloride 250g., Cobalt-0.8g., Copper 8g., Manganese 64g., Iron – 32G., Zn-40g., Iodine-0.8g., Flavomycin-100g., Spiramycin 5g., Dl-methionie-50g, Selenium 0.6g., Lysine 120g.

Table 2. Physical and chemical properties of the experimental clay.

Particle size (%)	
Clay	63.00
Total sand	37.00
pH value (H_2O)	4.10
Organic matter (%)	0.35
Nitrogen (%)	0.056
Exch. cations (Me/100g)	
Na^+	0.32
K^+	0.14
Ca^+	1.20
Mg^+	0.80
Cation exchange capacity Me/100g	24.00
Base saturation (%)	10.25
Exch. Acidity (Me/100g)	
Al^{3+}	-
H^+	6.80
P (ppm)	4.66
Ppm: part per million	

Cost Implications of Feeding Clay: The cost of feed per kg gain in body weight, cost of daily feed intake and cost of total feed consumed were least at 2, 3, 1 and 4 (in ascending order) % inclusion of natural clay on account of the lowest feed intake in these groups (Table 4). Thus higher feed costs were incurred by feeding birds on 5 and 0 % clay as expected from their higher feed consumption. In terms of cost of daily feed intake, 1% and 2% clay supplementation gave savings of ₦1.51 and ₦3.17, respectively over the control group and savings of ₦3.43 and ₦5.09, respectively over other treatment groups. The economic benefits of including clay in the diet is made more obvious by consideration of the total cost of feed consumed per treatment. Compared to control, savings of ₦302.4 and ₦675.77 were made with 1 and 2% clay supplementations, respectively while savings of ₦770.53 and ₦1143.9 were made, respectively compared to the 5% clay diet. Generally, birds fed diets with clay incurred overall least cost of feed consumed compared to the control (₦1682.73 vs ₦1868.46). It is obvious therefore,

that inclusion of clay in broiler ration can enhance not only performance but also the profitability of broiler enterprise. This contradicts the report by Damiri *et al*. (2010) who reported no effect of sodium bentonite clay on the economic value of broiler chicken. In the present research, feeding birds with diets containing 1 to 5% clay resulted in significant reduction in the cost of daily feed intake as opposed to feeding the birds with the control diet. This is of great economic advantage to the farmer.

Table 3. Growth performance of broiler starters fed diets with varying levels of clay

	Clay level (%)							
	0	1	2	3	4	5	SEM	P value
Parameter/treatment	A	B	C	D	E	F		
Initial body weight (g)	233.00	233.00	232.50	227.00	221.5	233.00	3.11	0.65
Final body weight (g)	921.50^{bc}	934.00^{bc}	889.00^{c}	831.00^{d}	865.50^{cd}	1011.00^{a}	19.13	0.05
ADFI (g)	50.50^{b}	45.50^{bc}	38.50^{c}	42.00^{c}	48.00^{b}	59.50^{a}	2.03	0.01
ADWG(g)	24.50^{b}	24.50^{b}	23.00^{bc}	21.50^{c}	22.50^{c}	27.00^{a}	0.61	0.04
FCR	2.10	1.89	1.68	1.95	2.13	2.20	0.57	0.68
Daily protein intake (g)	12.20	10.97	9.24	10.14	11.70	14.03	4.68	0.74
Protein efficiency ratio	2.10	2.23	2.49	2.12	1.92	1.92	0.98	0.82

a, b, c, d: means on the same row with different superscripts are significantly different ($p \leq 0.05$); ADFI: average daily feed intake; AVDWG: average daily weight gain; SEM: standard error of mean.

Table 4. Cost implications of feeding varying dietary levels of clay to broiler chicks

	Clay level (%)							
	0	1	2	3	4	5	SEM	P value
Parameter/treatment	A	B	C	D	E	F		
Feed cost/Kg (₦)	82.13	81.41	80.68	79.97	79.23	78.53	-	
Feed cost/Kg gain (₦)	172.50^{a}	153.86^{b}	135.54^{c}	155.94^{b}	168.76^{a}	172.66^{a}	4.16	0.05
Total feed cost (₦)	1868.46^{b}	1566.06^{c}	1192.69^{d}	1485.51^{c}	1832.79^{b}	2336.59^{a}	110.24	0.00
Cost of daily intake (₦)	8.39^{b}	6.88^{c}	5.22^{d}	6.55^{c}	8.11^{b}	10.31^{a}	0.49	0.04

a, b, c, d: means on the same row with different superscripts are significantly different ($p \leq 0.05$)

Conclusion: The results of the present study indicated that inclusion of clay in broiler diets up to 5% led to improvement in growth performance and reduction in cost of production.

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