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Effects of Dietary Kaolin Supplementation on the Growth Performance and Serum Chemistry of Broilers

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Target Audience: Poultry Farmers, Researchers, Feed Producers, Physiologists, Veterinarian, Consumers

Abstract

One hundred and sixty (160) Anak 2000 day-old broiler chicks were used to investigate the effects of kaolin on the haematology and growth performance of broilers. The chicks were randomly assigned to four treatments, each treatment consisting of four pens with 10 chicks per pen. The four treatments were; basal diet only (control group), basal diet + 10g/kg kaolin, basal diet + 20g/kg kaolin and basal diet + 30g/kg kaolin. For ten weeks, data from each treatment were collected weekly on the body weight, weight gain and feed conversion ratio. Feed intake was recorded daily. At the end of the 10th week of experiment, 8 birds were picked from each treatment, euthanized using chloroform and blood samples were collected for haematological analysis. Major digestive organs were excised and weighed. Data collected were subjected to one-way ANOVA in a completely randomized design. Results from growth studies revealed that supplementing broiler diet with kaolin significantly ($P < 0.05$) improved the body weight, weight gain, dressed weight and haematology compared to the control. Also, chicken fed kaolin-based diets had higher resistance to coccidian and diarrhoeal infections. It appeared that dietary supplementation with up to 20g kaolin/kg of diet had beneficial effects on the growth performance, carcass characteristics, disease resistance and haematology of broilers.

Keywords: Feed Additive, Broiler Performance, Serum Chemistry, Clay Supplementation

Description of Problem

Traditionally, clays have been incorporated into animal diets (10 to 20g/kg) as a technological additive (a lubricant/agglomerate) to improve feed manufacture (1). It has been reported that dietary supplementation with clay improves the nutrient digestibility and enzymatic activity of gastrointestinal secretion (2, 3). Xia *et al*. (4) also proposed that clay acts as enhancers of the nutritive value of diets. Kaolin, an aluminosilicate clay, has a 1:1 layer structure. The inner layer is composed of an octahedral- alumino- layer joined to the tetrahedral silica layer via apical oxygens (5). Due to these structural characteristics, kaolin has specific physio-chemical properties including low cation exchange capacity (6).

Animal feed containing clay minerals such as kaolin has been shown to promote weight gain and feed efficiency (7), to reduce bacterial contamination of the guts and to reduce the detrimental effects of mycotoxin – contaminated diets (8). Kaolin also protects the intestinal mucosa by adhering to pathogens and selectively promotes their excretion (9). Dietary clays have been applauded as an anti diarrhoeal remedy in human and animal medicine (10). Unlike in the developed economies, to the best of our knowledge, kaolin is yet to find its relevance as feed additive in broiler production in most developing tropical countries (including Nigeria) (2,4, 8).

This experiment was therefore conducted to investigate the effects of kaolin-based diets on the growth performance, carcass characteristics and haematology of broilers in a tropical environment.

Materials and Methods

The experiment was conducted at the poultry unit of the University of Calabar Teaching and Research Farms, Calabar, Nigeria. The lumps of Kaolin clay used in this study were purchased locally at Watt Market located in Calabar South Local Government Area of Cross River State. The lumps of kaolin clay were crushed and grounded into powdery form, then stored in an air tight container at room temperature until needed for ration formulation.

All procedures in this study were approved by the University of Calabar Animal Care and Use committee. One hundred and sixty (160) day-old Anak 2000 broiler chicks were assigned to four treatments; each treatment had four pens of 10chicks/pen. The dietary treatments were; basal diet (control group), basal diet +10g/kg kaolin,
basal diet +20g/kg kaolin and basal diet +30g/kg kaolin.

Diets were fed from day 1 to day 70 including; starter (day 1 to day 35) and finisher (day 35 – day 70) phases. Nutrient levels of the diets (Table 1) were based on the NRC (11) recommendations. Feeds were analyzed for crude protein, moisture, ash, ether extract and crude fibre according to the methods of AOAC (12). To monitor the effects of kaolin on the health status of the birds, antibiotics were excluded from all diets. Birds in all treatments were given *ad libitum* access to feed and water. Chicks were weighed individually at weekly interval to determine average daily gain (ADG). Feed consumed on pen basis, were recorded daily. Average daily feed intake and feed to gain ratio were calculated.

At day 70 of the feeding trial, 8 chicks per treatment were euthanized with chloroform. Their hearts were exposed and blood samples were collected into well labelled EDTA-bottles for haematological analysis (haemoglobin, white blood cells, red blood cells, packed cells volume concentrations) according to standard procedures (13). Major digestive organs were also excised, blotted and weighed. The carcasses were scalded to determine their dressed weights.

Data obtained were subjected to the one-way analysis of variance using GENSTA softwares. Means were also separated by the least significance difference method of the same software.

Table 1: Composition of Experimental diets (%)

	Composition (%)	
Ingredient	Starter (0-35days)	Finisher (35- 70 days)
Maize	40.32	44.20
Soya bean meal	36.18	30.30
Cray fish dust	10.00	10.00
Wheat offal	6.00	8.00
Palm kernel cake	3.00	3.00
Vitamin premix	0.50	0.50
Bonemeal	3.00	3.00
Salt	0.50	0.50
Lysine	0.30	0.30
Methionine	0.20	0.20
Total	**100**	**100**
Calculated composition		
Crude protein (%)	24.31	21.75
ME (kcal/kg)	2750	2750
Analyzed composition		
Crude protein (%)	23.38	21.75
Crude fibre (%)	4.76	5.00
Ether extract (%)	5.00	5.00
ME(kcal/kg)	2755.84	2763.00

[a]Supplied the following per kg of vitamin premix: Vitamin A 15,000,000iu; Vitamin D_3 3,000,000iu; Vitamin E 15,000iu; Vitamin K_3 2.5g; Vitamin B_1 1g; Vitamin B_2 10g; Vitamin B_{12} 4g; Folic Acid 2g; Biotin 0.1g; Niacin 70g; BHT 125g; Calcium –D-Pantotenic Acid 20g

Results and Discussion

Growth performance of broilers on kaolin-based diets is presented in Table 2. Compared to the control diet, increased supplementation with kaolin significantly ($P < 0.05$) improved the body weight and daily weight gain of broilers. No significant ($P > 0.05$) differences were observed between treatment on daily feed intake and feed conversion ratio. However, birds on the control diet recorded the highest feed intake and poorest feed conversion ratio.

Table 2: Effect of kaolin supplementation on broiler performance

Performance	Control	Treatments			SEM
		10g kaolin/kg	20g kaolin/kg	30g kaolin/kg	
Initial body weight (g)	40.10	30.90	40.00	41.00	0.08
Final body weight (g)	1402.50^{d}	1478. 00^{c}	1523.00^{b}	1590.00^{a}	52.44
Daily weight gain(g/d)	19.46^{c}	20.67^{bc}	21.19^{ab}	22.13^{a}	1.12
Daily feed intake (g/)	41.93	37.84	37.64	37.27	4.23
Feed conversion ratio	2.16	1.83	1.78	1.68	0.16

Different superscripts (a, b, c, and d) indicate significant ($p < 0.05$) differences along rows.
SEM - Standard error of mean

Results of previous experiments on the effects of clays on animal performance were generally inconsistent (2, 14). The feeding value of clays is known to be affected by the kind of clays, producing area, grade and their physio-chemical and structural characteristics. This present study agrees with the reports of Xia *et al.* (4); Tauqir and Nawaz (8) that rations supplemented with 10 – 30g/kg of clay promote weight gain and feed efficiency in chickens. It was observed that coccidian and diarrhoeal infections were minimal in birds on kaolin diets compared with the control group.

Table 3 reveals highly significant ($p < 0.001$) influences on final live weight, dressed weight, weights of the head, leg and neck following kaolin supplementation. Broilers on 20g kaolin/kg of diet had the highest dressed weight with the least value obtained from the control diet. This might suggest that supplementation with clay improves the dressed weight of broilers. Organ weights were also significantly ($p < 0.001$) influenced by dietary kaolin supplementation. Apart from bile weight, other organs were larger in birds on kaolin diets. Birds on 20g kaolin/kg consistently had the heaviest organ weight. This result might imply that kaolin supplementation at 20g/kg of diet promotes organ development.

Table 3: Effects of kaolin supplements on the carcass characteristics of broilers.

Characteristic	Control	Treatments			SEM
		10g kaolin/kg	20g kaolin/kg	30g kaolin/kg	
Carcass weights					
Live weight (g)	1402.50^{d}	1868.50^{b}	2100.00^{a}	1590.00^{c}	153.44
Dressed weight (g)	1068.80^{d}	1378.00^{b}	1523.00^{a}	1131.70^{c}	60.13
Head	44.54^{c}	50.78	52.15^{a}	48.83^{b}	1.66
Leg	87.15^{b}	95.58^{a}	97.39^{a}	94.93^{a}	2.26
Neck	76.42^{c}	91.89^{a}	92.23^{a}	85.12^{b}	3.71
Organ weights					
Oesophagus	2.49^{b}	2.46^{b}	3.22^{a}	2.38^{b}	0.19
Wind pipe	1.19^{c}	2.16^{b}	2.79^{a}	2.27^{b}	0.57
Crop	12.26^{c}	15.81^{a}	16.06^{a}	14.54^{b}	0.86
Proventiculus	6.71^{c}	6.83^{c}	9.67^{a}	7.43^{b}	0.68
Gizzard	51.72^{b}	53.28^{b}	74.53^{a}	53.35^{b}	5.44
Kidney	1.25^{c}	1.34^{c}	1.93^{bc}	2.26^{a}	0.24
Liver	40.26^{c}	48.95^{b}	54.17^{a}	51.41^{a}	3.01
Bile	3.15^{a}	1.25^{c}	1.32^{bc}	1.99^{b}	0.44
Pancreas	2.30^{d}	6.87^{a}	3.74^{c}	4.41^{b}	0.95
Heart	5.98^{c}	4.74^{d}	8.52^{a}	7.91^{b}	0.89
Intestinal weights					
Duodenum	39.02^{a}	22.48^{b}	18.14^{c}	22.13^{b}	2.63
Jejunum	35.35^{b}	19.75^{d}	49.35^{a}	25.13^{c}	6.51
Ileum	9.80^{b}	9.65^{b}	10.81^{a}	10.24^{a}	0.26
Caecum	9.98^{b}	12.24^{b}	16.15^{a}	14.06^{a}	1.31
Rectum	6.07^{a}	6.14	4.88^{c}	5.71^{b}	0.28

Different superscripts (a, b ,c and d) indicate significant ($p < 0.05$) differences along rows
SEM - Standard error of mean

On haematology of broiler (Table 4), compared with the control, birds fed kaolin-based diets had significantly ($p < 0.05$) higher PCV, WBC, RBC, MCV and MCHC concentrations. Whereas, the concentrations of Hb and MCH were not significantly ($P > 0.05$) different between treatments. The lower values for PCV, WBC and RBC concentrations might be indicative of possible stress and anaemic conditions in the birds as earlier reported by Schalm *et al*. (13). Haematological values were within the ranges reported in literature (15). This result is also consistent with the report of Coates *et al*. (16) that feed additive supplementation could improve the response of birds to several stressors and disease conditions.

Table 4. Haematological response of broilers to dietary kaolin supplementations.

Blood circulation	Control	Treatments			SEM
		10g kaolin/kg	20g kaolin/kg	30g kaolin/kg	
Hb (g/dl)	7.28	7.89	8.58	8.58	0.31
WBC ($10^b/mm^3$)	34^b	20^c	45^a	10^d	8.28
RBC ($10^b/mm^3$)	1.69^c	1.81^b	1.91^{ab}	2.09^a	0.08
PCV (%)	28.18^c	38.16^a	37.16^{ab}	36.52^b	1.81
MCV (fl)	16.67^c	21.08^a	18.22^b	17.47^{bc}	1.41
MCH (10pg)	4.30	4.36	4.49	4.11	0.07
MCHC(g/dl)	25.83^b	20.67^c	31.59^a	23.49^d	2.31

Different superscripts (a,b,c and d) indicate significant ($P < 0.05$) differences along rows.
SEM - Standard error of mean
Hb = Haemoglobin WBC= White blood cells RBC =Red blood cells
PCV = Packed cell volume MCV= Mean corpuscular volume
MCH = Mean corpuscular height MCHC = Mean corpuscular height concentration

Conclusions

The study concluded that;

1. Dietary kaolin supplementation has beneficial effects on broiler production.
2. It was recommended that up to 20g kaolin/kg diet should be supplemented in broiler diet for improved performance.

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