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Abstract

The effect of ferrous sulphate kaolin treated Moringa oleifera seedcake (FKMOSC) on performance, nutrient digestibility and blood characteristics of broiler chickens was investigated over eight weeks study period. This study investigated the effect of ferrous sulphate kaolin treated Moringa oleifera seedcake (FKMOSC) on performance, nutrient digestibility and blood characteristics of broiler chickens. One hundred and fifty day-old Arbor acre chickens used in this experiment were subjected to five dietary treatments as follows; Diet 1-the control, diet 2-raw (untreated MOSC), diets 3, 4, and 5 –FKMOSC at doses of 0.065, 0.130 and 0.260% ferrous sulphate and 0.01, 0.02 and 0.03% kaolin respectively at 5% level of inclusion. Broilers fed treated FKMOSC had similar ($p<0.05$) DWG, FI and FCR with the control (59.64 to 61.35 vs. 59.66; 101.98 to 105.00 vs. 103.43 g/bird/day and 1.45 to 2.38 vs. 1.45, respectively) and were significantly ($p<0.05$) better than values for raw MOSC. The haematological indices and serum chemistry of chickens fed treated MOSC were poorer than the control but significantly ($p<0.05$) better than those of raw MOSC. In conclusion, treatment of MOSC with ferrous sulphate kaolin was effective in reducing its anti-nutritional contents and can be used as protein supplement in poultry diet. This study recommends the combine use of 0.065% ferrous sulphate and 0.01% kaolin in treatment of MOSC for improvement of its nutritive value.

Key words: Moringa seed cake; broiler chickens; performance; biochemical; haematological indices

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Introduction

It is an established fact that feed represents the exorbitant item in any livestock industry, particularly poultry (Owen, *et al.* (2010). Any serious reduction or decline in the feed cost will lower the production cost and consequently the profit of the farm will be increased. Due to the high cost of the conventional feed stuffs like groundnut cake meal, soya bean, Owen, *et al.* (2009) reported that the focus of dietary research should tend towards feed manipulation. One of these non-conventional feed additives is kaolin or china clay, which is a fine, white substance found by the weathering of aluminous minerals such as feldspar. Because of its adsorption attributes and non-existence of primary noxiousness (Aremu,2020), kaolin usage is considered to be an easy and effective precaution against deleterious effects exerted by harmful substances present in the living organism and the environment (Heimann, (1984). Kasi *et al.,* (1995). Knezevich, (1998). Gebesh, (1999).

Savor (1984), investigated dietary kaolin as a feed additive involving qualitative and/or quantitative manipulation of animal nutrition to influence growth performance without seriously upsetting nutritional requirements of values. Diamond *et al*. (1999) and Gilardi *et al*. (1999), reported reduction of biological absorption of toxic agents particularly alkaloids and tannins in seeds and various fruits by geophagic behaviour of free-living birds.

Notwithstanding the merits of kaolin/geophagy in medicine and nutrition, clinical studies on the other hand showed that geophagy (kaolin consumption) caused mineral deficiency especially iron (Fe) suggested to be associated with anaemia occurrence (Halstead,1968). In contrary, Paterson and Staszak, (1977) reported that intake of kaolin combined with iron (Fe) resulted in normal levels of haemoglobin, haematocrit and erythrocytes counts and live birth weight of the young. However, other authors stressed the beneficial effects of kaolin (geophagy) on haemoglobin and serum ferritin levels with the believe that intake of clay soil substances are vital sources of iron and other minerals in the diet (Geissler *et al.,* 1998; Johns and Duguette 1991and Abrahams, 1997)

There is no information on the use of ferrous sulphate with kaolin for the treatment of *Moringa oleifera* seed cake for feeding broilers. Hence the study aims to investigate the effects of dietary raw and ferrous sulphate kaolin treated Moringa oleifera seedcake on performance, serum and haematological characteristics, and nutrient retention of broiler chickens under the tropical environment of guinea savannah of Nigeria.

Materials and Methods

Experimental site

The experiment was carried out in the Poultry Unit of the Teaching and Research Farm, Kwara State University, Malete, Kwara State, Nigeria.

Experimental Animals and their Management

20kg of *Moringa oleifera* seed cake used for this work was obtained from Moringa processing plant at Afe Babalola University, Ado-Ekiti, Nigeria. *Moringa oleifera* seed cake (MOSC) was properly sundried to a permanent weight and milled for replacing soyabean in the diets. Five experimental diets were formulated to meet NRC (1994), requirement for day old broiler chicks. A corn-soybean reference diet (diet 1) is devoid of *Moringa oleifera* seed cake (control) and four other diets containing raw (untreated MOSC) and ferrous sulphate-kaolin treated *Moringa oleifera* seed cake for replacing soyabean at doses of 0.065, 0.130 and 0.260% ferrous sulphate and 0.01, 0.02 and 0.03% kaolin respectively, corresponding to diets 1, 2, 3, 4 and 5 respectively at 5% level of inclusion (Table 1). One hundred and fifty day-old Arbor acre breed of broiler birds used for this experiment were obtained from Novic Farms, Ibadan, Oyo State Nigeria. The experiment was designed as a complete randomized design. The dietary treatments contained three replicates with 10 chicks per replicate. All the birds were raised under similar management practices throughout the eight-week experimental period. The birds were given feed and water *ad-libitum* and weighed weekly. The composition of the experimental diets for the broilers is presented on Table 1.

Data Collection

At the end of the experiment, one broiler per replicate in all the treatments was taken at random for blood collection by decapitation. Blood for biochemical indices was collected in bottles without EDTA for the analysis of the biochemical parameters such as total protein, albumin, globulin, urea, and transaminase activities (serum aspartate amino transaminase (AST), alanine amino transaminase (ALT) and alkaline phosphatase (ALP)). The blood samples for haematological parameters were pretreated with ethylene diamine tetra-acetic acid (EDTA). Haematological indices examined include White Blood Cell (WBC), Red Blood Cell (RBC), Packed Cell Volume (PCV), Haemoglobin (Hb). Mean Cell Volume (MCV), Mean Cell Haemoglobin (MCH) and Mean Cell Haemoglobin Concentration (MCHC) were calculated from the values of the RBC, PCV and Hb respectively, according to the methods of Jain (1986).

Data Analysis

Data collected on the response criteria were subjected to analysis of variance in a completely randomized design model and differences between treatment means were separated using the Duncan's multiple range test (Steel and Torrie 1980).

Results and discussion

Performance Characteristics of Broiler Chickens Fed Ferrous Sulphate Kaolin Treated Moringa Oleifera Seed Cake based Diets

The performance characteristic of broilers fed ferrous sulphate kaolin treated *Moringa oleifera* seed cake (MOSC) diets were presented on Table 2. The feed intake values were remarkably ($p<0.05$) affected by the dietary replacements of soyabean with raw MOSC but comparable between the birds on control group and treatment groups in the average daily feed consumption with the addition of doses of ferrous sulphate kaolin *Moringa oleifera* seed cake in the diet of the birds.

Nutrient Digestibility of Broiler Chickens Fed Ferrous Sulphate Kaolin Treated Seed Cake based diets

The nutrient digestibility of broilers fed with ferrous sulphate kaolin treated MOSC diet were presented on Table 3. The nutrient digestibility of protein, fat and fibre were significantly ($p<0.05$) affected with the incorporation of doses of ferrous sulphate kaolin treated *Moringa oleifera* seed cake in the diet of the birds. The trend in the crude protein, fat and fibre digestibility showed that the birds on the raw diet (treatment 2) had poor crude protein, fat and fibre digestibility compared with its counterparts in other treatment groups.

Haematological indices of Broiler Chickens Fed Ferrous Sulphate Kaolin Treated Moringa Oleifera Seed Cake based diets

Haematological indices of the birds fed with ferrous sulphate kaolin treated *Moringa oleifera* seed cake-based diets were presented in Table 4. The red blood cells mean cell volume were affected ($p<0.05$) with the inclusion of graded level of ferrous sulphate kaolin treated *Moringa oleifera* seed cake in the diet of the birds. WBC, haemoglobin, and PCV, were significantly ($p<0.05$) different among the treatment groups and birds on the raw diets.

Serum Biochemical indices of Broiler Chickens Fed Ferrous Sulphate Kaolin Treated Moringa Oleifera Seed Cake based Diets

The biochemical indices of the broiler chickens fed dietary ferrous sulphate kaolin treated MOSC based diet were presented on Table 5. There were increased ($p<0.05$) in the serum urea, total protein, and albumin with the inclusion of doses of ferrous sulphate kaolin treated *Moringa oleifera* seed cake in the diet of the birds. The serum aspartate amino transaminase (AST), alanine amino transaminase (ALT) and alkaline phosphatase (ALP) activities of the birds decreased ($p<0.05$) with the incorporation of doses of ferrous sulphate kaolin treated *Moringa oleifera* seed cake in the diet of the birds.

Discussion

Growth performance characteristics: The improved growth performance of birds fed with the doses of ferrous sulphate kaolin in the diets of the birds indicates the efficiency of the feedstuff in poultry feeding. This result is consistent with the reports of Tauqir and Nawaz (2001) and Xia *et al*., (2004) who reported that rations augumented with 10-30g/kg clay enhanced feed efficiency in birds. Lowest feed intake (93.10g/bird/day) and weight gain (41.01g/bird/day) were recorded in birds fed untreated diet (diet 2). This finding may be a result of intrinsic anti-nutritients in *Moringa oleifera* seed cake. Increased feed intake observed in birds fed treated *Moringa oleifera* seed cake diets could be attributed to adequate nutrient utilization occasioned by the relatively low dietary fibre and reduced anti-nutritional factor (National Research Council, 1994).

The average daily weight gains of the birds were exceptionally ($p<0.05$) affected by the dietary incorporation of raw MOSC for replacement of soyabean. Except for the raw diet (diet 2), there was a decrease but comparable average daily weight gains of the birds ($p>0.05$) with the inclusion of treated feed materials. (Mumpton,1999), reported that animal feed having clay minerals such as kaolin enhanced weight gain and feed efficiency. Zero record of mortality observed in this study is an evidence that suggests that most of the anti- nutrients in the treated MOSC diets might have been removed or eliminated. Some of these anti-nutrients are recognized to induce death in animals. Tannins bound with and lowered absorption of iron in the gut (Butler, 1989).

In this study, the nutrient digestibility of the birds fed the treated MOSC was better than those fed with raw MOSC diet and the better nutrient digestibility of the birds fed with the doses of ferrous sulphate kaolin treated MOSC implies the effectiveness of the processing of raw MOSC for broilers. Haematological parameters such as Packed Cell Volume (PCV), Haemoglobin (Hb) and Total Protein (TP) were observed to be better for the control diet than for the MOSC diets

The non-significant ($p>0.05$) difference in serum urea between the control and the treated group agrees with the results of Eggum (1976); Esonu *et al.,* (2001); Iyayi and Taiwo (2003) who reported that total protein and serum urea contents depend on the quality and quantity of the protein provided in the diet. The increase in albumin and total protein with the inclusion of doses of ferrous sulphate kaolin in the diets of the birds underscore the nutritional acceptability of treated MOSC in satisfying the protein requirement of the chickens. ALP, AST and ALT decreased with the inclusion of doses of ferrous sulphate kaolin in the diets of the birds. The increase in ALT values in birds in treatments 2, compared with the control and treated group suggest that there may be a likelihood of liver damage by the raw MOSC.

Conclusion

From this study, broilers fed treated MOSC diet performed better than those fed raw MOSC diet while those fed the control diet performed significantly better than those fed raw and treated MOSC diet respectively. The adopted treatment method in this study was not sufficient to totally detoxify the anti-nutrients present in MOSC. The best result obtained from replacing soyabean with treated *Moringa oleifera* seed cake diet was combine use of 0.065% ferrous sulphate and 0.01% kaolin in treatment of MOSC at 5% inclusion level

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Tables

Table 1: Composition (%) of the Experimental Diets

	Dietary treatment (%)				
Ingredients (%)	0(control) 0	Raw(untreated) 0	0.065(FS) + 0.01(Kaolin)	0.130(FS) + 0.02(Kaolin)	0.260(FS) + 0.03(Kaolin)
Maize	52.00	52.00	52.00	52.00	52.00
FKMOSC[a]	0.00	5.00	5.00	5.00	5.00
Soybean meal	31.00	26.00	26.00	26.00	26.00
Fish meal	2.00	2.00	2.00	2.00	2.00
Wheat offal	10.00	10.00	10.00	10.00	10.00
Palm oil	1.50	1.50	1.50	1.50	1.50
Bone meal	1.15	1.15	1.15	1.15	1.15
Oyester shell	1.50	1.50	1.50	1.50	1.50
*Vit/Min premix[b]	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10
DL-Methionine	0.25	0.25	0.25	0.25	0.25
Nutrients[c]					
Crude protein	23.13	22.98	23.04	23.02	23.10
Crude fibre	5.83	5.95	5.80	5.11	5.10
Fat	8.10	5.15	4.95	4.81	5.25
ME (Kcal/kg)	2624	2624	2623	2624	2623
Lysine	1.17	1.17	1.17	1.17	1.19
Methionine	0.52	0.52	0.53	0.53	0.49

FS= Ferrous sulphate, K= Kaolin, MOSC= Moringa oleifera seed cake
[b]Provided 1.5 mg retinol, 25 mg cholecalciferol, 16 mg Į-tocopherol, 1mg menadione, 0.8 mg thiamine, 2.4 mg riboflavin, 14 mg nicotinic acid,4 mg calcium D-pantothenate, 1.4 mg pyridoxine, 10 mg cyanocobalamin, 0.4 mg folic acid, 0.02 mg biotin, 120 mg choline chloride, 0.62mg zinc bacitracin, 36 mg avaten, 40 mg Mn, 18 mg Zn, 0.8 mg Cu, 0.09 mg Co, 20 mg Fe and 0.04 mg Se kg^{-1} diet; [c]Determined values except for metabolisable energy (ME), lysine and methionine which were calculated from the published (NRC, 1995) compositions of the ingredients used.

Table 2: Performance Characteristics of Broiler Chickens Fed Ferrous Sulphate Kaolin Treated *Moringa Oleifera* Seed Cake based Diets

	Dietary treatment					
Parameters	0(control)	0(Raw)	0.065(FS) 0.01(K)	0.130(FS) 0.02(K)	0.260(FS) 0.03(K)	SEM
Daily weight gain (g/bird/day)	59.66[b]	41.01[c]	61.35[a]	60.20[ab]	59.64[b]	0.72
Feed intake (g/bird/day)	103.43[a]	93.10[b]	104.76[a]	105.00[a]	101.98[a]	2.32

FS= Ferrous sulphate, K= Kaolin, MOSC= Moringa oleifera seed cake, Raw= untreated, SEM= Standard error of mean=P<0.05Means with different superscript along the same rows are significantly (P<0.05), MOSC=Moringaoleifera seed cake*

Table 3: Nutrient Digestibility of Broiler Chickens Fed Ferrous Sulphate Kaolin Treated Seed Cake based diets

Parameters (%)	Dietary treatment 0(control)	0(Raw)	0.065(FS) 0.01(K)	0.130(FS) 0.02(K)	0.260(FS) 0.03(K)	SEM
Crude protein	71.600^{b}	49.210^{c}	73.620^{a}	72.240^{ab}	71.570^{b}	0.863
Crude fibre	65.570^{b}	70.063^{c}	67.420^{a}	66.160^{ab}	65.540^{b}	0.791
Fats	65.300^{a}	55.103^{c}	67.490^{a}	66.220^{ab}	65.600^{b}	0.7971

FS= Ferrous sulphate,K= Kaolin, MOSC= Moringa oleifera seed cake, Raw= untreated, SEM= Standard error of mean; Means with different superscript along the same rows are significant (P<0.05).

Table 4: Haematological Indices of Broiler Chickens Fed Ferrous Sulphate Kaolin Treated *Moringa Oleifera* Seed Cake based diets

Parameters	Dietary treatment 0(control)	0(Raw)	0.065(FS) 0.01(K)	0.130(FS) 0.02(K)	0.260(FS) 0.03(K)	SEM
PCV(%)	31.20^{a}	25.60^{a}	31.30^{a}	29.85^{a}	30.60^{a}	1.405
Mean Cell Volume (fl)	132.25^{ab}	129.60^{b}	136.10^{a}	137.00^{a}	136.55^{a}	3.372
MCH (pg)	37.15^{a}	36.95^{a}	39.15^{a}	39.00^{a}	38.80^{a}	1.216
MCHC (g/dl)	28.05^{a}	28.55^{a}	28.75^{a}	28.50^{a}	28.45^{a}	0.402
WBC (x 10^{9}/l)	231.00^{a}	233.85^{a}	229.65^{a}	226.10^{a}	231.25^{a}	4.706

FS= Ferrous sulphate,K= Kaolin, MOSC= Moringa oleifera seed cake, RBC= Red Blood Cell, PCV=Packed Cell Volume, Mean Cell Haemoglobin (MCH) and Mean Cell Haemoglobin Concentration (MCHC), WBC= White Blood Cell, Raw= untreated, SEM= Standard error of mean=P<0.05; Means with different superscript along the same rows are significantly (P<0.05)

Table 5: Serum Biochemical Indices of Broiler Chickens Fed Ferrous Sulphate Kaolin Treated *Moringa Oleifera* Seed Cake based Diets

	Dietary treatment					
Parameters	0(control)	0(Raw)	0.065(FS) 0.01(K)	0.130(FS) 0.02(K)	0.260(FS) 0.03(K)	SEM
Urea (mmol/l)	4.657[b]	8.070[a]	4.767[b]	4.727[b]	4.663[b]	0.115
Total protein (g/l)	13.927[b]	10.230[c]	12.020[b]	13.440[a]	13.003[a]	0.186
Albumin (g/l)	3.727[a]	2.463[b]	3.500[a]	3.703[a]	3.667[a]	0.239
Aspartate Aminotransaminase(U/L)	70.000[b]	90.030[a]	62.107[c]	68.840[c]	70.843[b]	6.779
Alanine Aminotransaminase(U/L)	19.480[b]	30.443[a]	19.867[d]	18.037[c]	19.460[c]	1.059
Alkaline phosphatase(U/L)	35.680[a]	46.287[a]	34.660[c]	32.540[b]	30.840[b]	3.839

FS= Ferrous sulphate,K= Kaolin, MOSC= Moringa oleifera seed cake, Raw= untreated, SEM= Standard error of mean=P<0.05Means with different superscript along the same rows are significantly (P<0.05), MOSC=Moringa oleifera seed cake*