Influence of dietary lanthanum oxide (La_2O_3) on the blood characteristics and ovarian morphometry of broiler chickens

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Abstract

The use of antibiotics as feed additives in animal production has been a source of health concern. A practical approach is the supplementation of animal feeds with rare earth element. Thus, this study was carried out with 225 day – old broiler chicks (CHI strain) to evaluate the influence of dietary Lanthanum oxide (La_2O_3) on the blood characteristics and ovarian morphometry. The feeding trial lasted eight weeks before the parameters were determined. The dietary treatments were designated as T_1 , T_2 , T_3 , T_4 and T_5 . The T_1 served as the negative control without La_2O_3 while T_2 was the positive control with antibiotic. La_2O_3 was supplemented to T_3 , T_4 , T_3 , and T_5 at 100, 200 and 300 ppm, respectively. The birds were divided into five groups of 45 each and randomly assigned to the five experimental diets using a completely randomized design (CRD). Each treatment was further divided into three replicates of fifteen (15) birds each and reared in a brooding unit and later on a deep litter house. Feed and water were provided ad-libitum. Results showed that the haematological parameters were not significantly ($P>0.05$) influenced by dietary treatments, except the differential leucocytes (eosinophils, lymphocytes and neutrophils); while in terms of the serum- biochemical indices, only cholesterol and bi-carbonate contents were significantly ($P<0.05$) influenced by dietary treatments. The ovarian weight was significantly ($P<0.05$) influenced by dietary treatments. The results of this study suggest that dietary La_2O_3 up to 300 ppm will not adversely affect the blood (haematological and serum biochemical) characteristics and ovarian morphometry of broiler chickens.

Keywords: Broiler chickens, blood, ovary, lanthanum oxide

Introduction

In extant practice of animal production, the use of antibiotics as feed additives has been a source of health concern. In many developed countries especially Europe, the use of anti-bacterial growth promoters in poultry and swine diets has been totally banned (Rambeck and Wehr, 2005); and many other countries are gradually adopting organic livestock production that excludes the use of antibiotics. A novel approach is the supplementation of animal feeds with rare earth element (REEs). The REE is the common name for the metallic elements of the Lanthanide series together with yttrium and scandium which make up 0.0016% of the earths crust (Lei and

Xuejing, 1997). The incorporation of natural products such as lanthanum oxide to animal feeds is gaining the attention of researchers (Evans, 1990). Lanthanum which belongs to the group of elements called rare earth metals is not rare at all. Lanthanum is available in relatively large quantities (32 ppm in the earth crust). Lanthanum is mostly obtained from monazite and bastnasite. This mineral mixture is crushed and grind and is separated as double salt with ammonium nitrate by crystallization. The use of lanthanum oxide as feed additive for poultry (broiler chickens) production may have a desirable effects replacing antibiotics. Lanthanum oxide has also been successfully applied as feed additive to

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other livestock species with a positive effect on body weight gain. Rare earth elements have been shown to influence growth performance in animal production especially in poultry (Rambeck and Wehr, 2005).

Blood examination has its tangible value in poultry rearing business, because it provides information on the assessment of poultry health such as traumatic injury, parasitism, bacterial septicemia and nutritional deficiencies as well as physiological changes in growth with time of broiler chickens (Jain, 1993). According to Sturkie (1995), haematological values in birds could be influenced by many factors such as age, gender, hormones, hypoxia and environmental conditions.

A lot of results on the effect of REEs on blood characteristics of poultry species have been published elsewhere, especially in Chinese literature. However, there is paucity of research findings on the effect of rare earth elements on the blood characteristics and ovarian morphometry of broiler chickens in the tropics; hence the main objective of this study was to determine the influence of dietary lanthanum oxide on the blood (haematological and serum biochemical characteristics) and ovarian morphometry of broiler chickens in a typical rainforest belt of Nigeria.

Materials and methods

Study location

The study was carried out at the Poultry Unit of the Teaching and Research Farm, University of Calabar, Calabar, Cross River State. Calabar is located within the rainforest, south-south zone of Nigeria with a mean annual rainfall of about 1830 mm and average annual temperature of 24 ° (75 °F) to 30 °C (86 °F) (Asuquo and Okon, 2012).

Experimental birds, diets and management

A total of 225 day - old chicks of *CHI* strain were used in this study. They were divided into five treatments and replicated thrice with 15 birds per replicate. Five experimental diets were formulated (Tables 1 and 2) for starter and finisher phases, respectively. Diet 1 served as the negative control containing (0 ppm La 0), while diet 2, had antibiotic as the positive control and diets 3, 4 and 5 had 100, 200, and 300 ppm levels of La 0 , respectively. Feed and water were provided *ad libitum* to the birds throughout the eight weeks duration of the study.

At day old, the chicks were weighed and randomly allotted to the dietary treatments in a completely randomized design. They were brooded and fed experimental diets. During the feeding trial, the birds were housed in a deep litter floor with adequate spacing, ventilation and protection against predators and other environmental conditions. The birds were vaccinated against Newcastle disease at day old intraocularly and Lasota at the 18th day through drinking water. Infectious bursal (gumboro) disease vaccine was administered twice on the 10th and 17th day and other routine management procedures for broiler birds were also carried out.

Proximate analysis of experimental diets

The proximate analysis of the experimental diets was carried out based on standard methods of AOAC (2000).

Blood collection

At the end of the feeding trial, nine birds (three per replicate) were randomly selected for blood collection. About 2mL of blood were collected per bird. The collection was done by puncturing the prominent wing vein with a 5 mL scalp vein needle and syringe. Two separate blood samples were collected immediately; one sample into a

Table 1: Composition of experimental diets (Starter phase)

Ingredient	T ₁ (0ppm)	T ₂ (Antibiotic)	T ₃ (100ppm)	T ₄ (200ppm)	T ₅ (300ppm)
Yellow maize	50.00	50.00	50.00	50.00	50.00
Soybean meal	32.00	32.00	32.00	32.00	32.00
PKC	4.45	4.44	4.44	4.43	4.42
Wheat offal	5.00	5.00	5.00	5.00	5.00
Crayfish dust	5.00	5.00	5.00	5.00	5.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Methionine	0.30	0.30	0.30	0.30	0.30
Lysine	0.25	0.25	0.25	0.25	0.25
Antibiotic	0.00	0.01	0.00	0.00	0.00
Premix	0.50	0.50	0.50	0.50	0.50
Palm oil	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
La ₂ O ₃	0.00	0.00	0.01	0.02	0.03
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis:					
% CP	23.30	23.30	23.30	23.30	23.30
% CF	3.93	3.93	3.93	3.93	3.93
ME (Kcal/kg)	2,840.29	2,840.07	2,840.07	2,837.85	2,836.64
Determined analysis:					
% CP	22.75	22.55	23.00	23.25	23.35
% CF	3.00	3.25	3.80	3.85	3.96

Table 2: Composition of experimental diets (Finisher phase)

Ingredients	T ₁ (0ppm)	T ₂ (Antibiotic)	T ₃ (100ppm)	T ₄ (200ppm)	T ₅ (300ppm)
Yellow maize	55.00	55.00	55.00	55.00	55.00
Soybean meal	25.00	25.00	25.00	25.00	25.00
PKC	4.45	4.44	4.44	4.43	4.42
Wheat offal	7.00	7.00	7.00	7.00	7.00
Crayfish dust	5.00	5.00	5.00	5.00	5.00
Bone meal	1.80	1.80	1.80	1.80	1.80
Methionine	0.20	0.20	0.20	0.20	0.20
Lysine	0.15	0.15	0.15	0.15	0.15
Premix	0.20	0.20	0.20	0.20	0.20
Palm oil	1.00	1.00	1.00	1.00	1.00
Salt	0.20	0.20	0.20	0.20	0.20
Antibiotic	0.00	0.01	0.00	0.00	0.00
La ₂ O ₃	0.00	0.00	0.01	0.02	0.03
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis:					
% CP	20.80	20.80	20.80	20.80	20.80
% CF	3.98	3.98	3.99	3.99	3.99
ME (Kcal/kg)	2,920.79	2,920.57	2,920.56	2,920.35	2,920.14
Determined analysis:					
% CP	19.75	19.77	19.90	19.95	19.97
% CF	4.50	4.56	4.58	4.60	4.61

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set of sterile plastic bottles containing ethylene diamine tetra acetic acid (EDTA) as the anticoagulant for determination of haematological parameters and the other into unheparinized test tubes for serum biochemical indices.

Haematological and serum biochemical assay

All blood parameters were estimated by standard methods as described in Dacie and Lewis (1991).

Ovarian morphometry

Two female broiler chickens from each replicate were purposively selected and weighed before slaughtering and the ovaries were carefully removed *intoto*. The weight of the ovaries were determined in grams (g) using sensitive electronic scale and their respective lengths were also determined using the glass rule.

Statistical analysis

The data obtained in the study was subjected to one - way analysis of variance for completely randomized design (Steel and Torrie, 1980). Significant means were separated using Duncan Multiple Range Test (DMRT).

Results

The hematological and serum biochemical

characteristics of broiler chickens fed La_2O_3 supplemented diets are presented in Tables 3 and 4, respectively. The results revealed that only the differential WBCs (eosinophils, neutrophils and lymphocytes) were significantly ($P<0.05$) influenced by dietary treatments, while all other haematological parameters such as PCV (32.50, 36.90, 34.00, 29.70 and 30.40%) ; MCV (160.90, 156.00, 147.90, 145.70 and 156.20 fl), RBC ($2.03, 2.37, 2.43, 2.04$ and $1.95 \times 10^9/\text{g/L}$), WBC (248.30, 256.00, 244.30, 233.20 and 236.10 $10^9/\text{g/L}$) T_1, T_2, T_3, T_4 and T_5 , respectively were not influenced by dietary treatments. In terms of serum biochemical indices only cholesterol and bi – carbonates were significantly ($P<0.05$) influenced by dietary treatments.

The results of the ovarian morphometry of the broiler chickens fed La_2O_3 supplemented diets are presented in Table 5. The ovarian weight was significantly affected ($P<0.05$) by dietary treatments. The live weight of the broiler chickens recorded 2350.00, 2400.00, 2150.00, 1950.00 and 2300.00 g/bird for T_1, T_2, T_3, T_4 and T_5 , respectively. The ovarian length of the broiler chickens recorded 1.30, 1.50, 1.47, 1.30 and 1.30mm for T_1, T_2, T_3, T_4 and T_5 , respectively.

Table 3: Haematological characteristics of broiler chickens fed La_2O_3 supplemented diets (8th week)

Parameters	$T_1(0\text{ppm})$	$T_2(\text{Antibiotic})$	$T_3(100\text{ppm})$	$T_4(200\text{ppm})$	$T_5(300\text{ppm})$	S.E.M
PCV (%)	32.50	36.90	34.00	29.70	30.40	2.61
HGB(g/dl)	8.63	10.30	10.70	8.80	8.77	0.91
RBC($\times 10^9/\text{g/L}$)	2.03	2.37	2.43	2.04	1.95	0.26
Platelets($\times 10^9/\text{g/L}$)	37.00	15.30	31.70	21.70	30.30	14.57
MCHC (%)	26.63	28.10	31.53	29.90	28.87	1.18
MCH(Pg)	42.90	43.60	46.70	43.20	45.00	3.30
MCV(fl)	160.90	156.00	147.90	145.70	156.20	11.39
WBC($10^9/\text{L}$)	248.30	256.00	244.30	233.20	236.10	7.97
WBC differentials:						
Basophils	0.00	0.01	0.00	0.00	0.00	0.00
Eosinophils	0.05 ^b	0.09 ^{ab}	0.19 ^{ab}	0.16 ^{ab}	0.24 ^a	0.05
Lymphocytes	1.17 ^b	1.53 ^{ab}	1.73 ^{ab}	2.30 ^a	2.13 ^a	0.26
Mesophils	0.16	0.30	0.13	0.23	0.20	0.06
Neutrophils	1.77 ^b	2.53 ^{ab}	3.20 ^{ab}	2.13 ^{ab}	2.70 ^a	0.42

^{a,b}Means on the same row with different superscripts are significantly different ($P<0.05$)

Key: MCHC: Mean corpuscular haemoglobin concentration; RBC: Red blood cell counts; MCH: Mean corpuscular haemoglobin; MCV: Mean corpuscular volume; HGB: Haemoglobin; PCV: Packed cell volume; WBC: White blood cell counts

Table 4: Serum biochemical characteristics of broiler chickens fed La₂O₃ supplemented diets (8th week)

Parameters (g/l)	T ₁ (0ppm)	T ₂ (Antibiotic)	T ₃ (100ppm)	T ₄ (200ppm)	T ₅ (300ppm)	S.E.M
Glucose	3.52	3.66	3.91	4.15	4.27	0.28
Total protein	6.83	7.75	8.18	7.71	8.21	0.66
Albumin	4.37	4.96	5.23	4.93	5.26	0.42
Globulin	2.46	2.79	2.95	2.78	2.96	0.24
Cholesterol	3.30 ^b	3.49 ^{ab}	3.62 ^{ab}	4.01 ^a	3.02 ^b	0.23
TGL	0.81	0.91	0.87	1.14	1.46	0.25
HDL	2.46	2.37	2.48	2.51	3.12	0.22
LDL	0.47	1.07	0.88	0.04	0.36	0.36
Urea	14.30	17.40	21.60	22.20	25.30	4.44
Potassium	5.02	5.10	5.45	6.00	6.16	0.28
Bi- carbonate	32.69 ^b	33.60 ^b	38.81 ^{ab}	37.21 ^{ab}	41.66 ^a	1.92

^{a,b}Means on the same row with different superscripts are significantly different (P<0.05); TGL:Triglycerides; HDL:High density lipoprotein; LDL:Low density lipoprotein

Table 5: Ovarian morphometry of female broiler chickens fed La₂O₃ supplemented diets (8th week)

Parameter	T ₁ (0ppm)	T ₂ (Antibiotic)	T ₃ (100ppm)	T ₄ (200ppm)	T ₅ (300ppm)	S.E.M
Live weight (g)	2350.00	2400.00	2150.00	1950.00	2300.00	211.00
Ovary length (mm)	1.30	1.50	1.47	1.30	1.30	0.14
Ovary weight (g)	0.75 ^b	1.10 ^a	1.09 ^a	0.85 ^b	0.80 ^b	0.06

^{a,b}Means of the same row with different superscripts are significantly different (P<0.05)
S.E.M: Standard Error of Mean

Discussion

Haematological characteristics of broiler chickens fed La₂O₃ supplemented diets

The haematological values were within the normal ranges for broilers as reported by Maxwell (1990); Tewe and Egbunike (1992). This implies that the chickens fed La₂O₃ supplemented diets did not record adverse blood characteristics. According to Muhammad and Oloyade (2009), bacterial and viral diseases affect the number of white corpuscles and the ratio between the different types of white corpuscles and the percentages of the various types in healthy animals vary slightly but are greatly modified in sick animals. The white blood cell counts did not differ significantly (P>0.05) between the dietary treatments. The white blood cell counts (WBC) 248.30, 256.00, 244.30, 233.20, 236.10 x 10⁹/L) were obtained for birds fed diets containing 0 ppm (control),

antibiotic, 100, 200 and 300 ppm La₂O₃, respectively. The WBC was highest in birds fed antibiotic (256.00 x 10⁹/L). The values obtained in this study are an indication of the quality of the supplemented diets as haematological parameters are a reflection of the animal responsiveness to both external and internal factors which include feed and feeding. According to Togun *et al.* (2007), when the haematological values fall within the normal ranges, it is an indication that the diets did not have any adverse effects on haematological values. Differences observed in packed cell volume (PCV) and mean corpuscular volume (MCV) for animals in different treatment groups may be attributed to the physiological and nutritional status of the animals (Esonu *et al.*, 2001).

Serum biochemical indices of broilers chickens fed La₂O₃ supplemented diets

The serum biochemical indices were within

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normal ranges for broilers according to Kaneko (1997). The results showed the serum cholesterol and bi-carbonate were significantly ($P < 0.05$) different between dietary treatments. Kaneko (1997) has shown that ranges of serum biochemical indices vary from species to species and can be influenced by many biotic and abiotic factors such as water temperature, seasonal pattern and feed. According to Hrubec *et al.* (2001), increased total protein concentration can be caused by structural liver alterations that reduce aminotransferase activity. Hill (1982) reported that cholesterol concentrations increase as the poultry size increased. A high blood urea concentration recorded in T_5 (25.30 g/l) is likely to be a sign of stress associated with the increase in serum potassium (K^+). ***Ovarian morphometry of broiler chickens fed La_2O_3 supplemented diets*** The highest mean ovarian length, ovarian weights of experimental birds were recorded in T_1 (negative control) and the lowest ovary weight was observed in T_5 (300 ppm). The findings in the present study may indicate that broiler chicks fed diets with La_2O_3 performed better with no adverse effect on the ovarian length. The low ovarian weight observed in birds fed diets with 300 ppm La_2O_3 could be due to several factors such as feed and feeding. Maxwell *et al.* (1990) reported that as the La_2O_3 concentration increased, there was a decreased in ovarian weight and ovarian length which also corresponded with the result of this study (Table 5). Also the fact that there were no significant variations in the ovarian length of birds across dietary treatments further indicated the *Lanthanum* oxide when moderately used cannot depress the ovarian activity.

Conclusion

Lanthanum oxide can be used to replace

antibiotics without adverse effects on haematological, serum biochemical characteristics and ovarian morphometry of broiler chickens. From all indications and with the experimental limits of the present study, the La_2O_3 supplemented diets appeared to have promising results compared to the negative and positive control diets. It is therefore recommended that farmers can supplement up to 300 ppm lanthanum oxide (La_2O_3) in the diets of broiler chickens, without fear of compromising the haematopoietic and ovarian activity of the poultry species.

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