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Ascorbic Acid for Broiler Chickens under Dietary Lead Exposure: Effects on Carcass Yield and Organs Weight

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Abstract: This study was to evaluate the effects of increasing doses of ascorbic acid (AA) on the carcass yield and organs weight characteristics of broilers submitted to dietary lead acetate (LA) exposure. 120 day-old broiler chicks were randomly assigned to six treatment groups with two replicates of 10 birds each. Six isonitrogenous and isocalories experimental diets were compounded and fed to birds *ad libitum* for seven weeks: T_1 (control group) received basal diet I (0mg LA and 0mg AA/kg feed), T_2 received diet II (200mg LA/kg feed and 0mg AA/kg feed), T_3 received diet III (200mg LA and 50mg AA/kg feed), T_4 received diet IV (200mg LA and 100mg AA/kg feed), T_5 received diet V (200mg LA and 150mg AA/kg feed) and T_6 received diet VI (200mg LA and 200mg AA/kg feed). Absence of AA in T_2 significantly *($P<0.05$)* reduced the weights of the breast, thigh and drumstick, while it significantly *($P<0.05$)* increased splenomegaly, weights of gizzard and proventriculus. However, birds exposed to LA and AA supplementations compared favourably with the control. LA at 200mg/kg feed had negative effects on carcass yield and organ weights; however, AA at varying experimental levels performed an ameliorative role on the toxic effects of lead in broiler chickens.

Key words: Ascorbic Acid・Broiler・Carcass・Lead・Nigeria・Organs Weight

INTRODUCTION

Over the last several years, poultry has become a very popular and promising sector in Nigeria and this has resulted in an increase in the number of commercial poultry feed producers. The raw materials for the production of poultry feed are of various origin. The exposure of these sources to various anthropogenic pollutants [1], especially heavy metals like lead may affect poultry food chain through the feed. Lead is ubiquitous and has been the intense focus of environmental health researchers [2, 3]. The main sources of contamination of feed by lead are soil, industrial pollution and agricultural technology as well as feed processing [4]. Also, majority of wood shavings used as litter materials come from woods painted with lead-base paints and can serve as source of lead poisoning to birds [5]. Another source of lead is contaminated bone and blood meal which form part of major feed ingredients for poultry and majority of the bones and blood used for this purpose come from cattle. However, cattle are the most susceptible to lead poisoning [6] with highest lead accumulation in their bones.

Considering the foregoing, AA has been reported to have curative effects due to its properties by many authors. A study of the influence of AA on the tissue deposition of lead in rats suggested that ascorbic acid might be useful as a prophylactic agent for lead poisoning

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[7]. Later studies in rats demonstrated that AA decreases the intestinal absorption of lead [8] and increases the renal clearance of lead [9]. Contrary to Niazi *et al.* [9], recently, Ibitoye *et al.* [10], reported that supplementation with AA at graded daily doses had no beneficial effect on lead toxicokinetics and elimination in broilers.

In their investigations to evaluate the effects of dietary lead poisoning on performance of broiler chickens, Morgan *et al.* [11] and Erdogan *et al.* [12], reported that, dietary lead significantly reduce body weight and body weight gain. Vodela *et al.* [13], also reported that, addition of a heavy metal mixture (including lead) to broiler drinking water depressed growth, but, supplementation with AA at graded levels, reversed the negative effect of dietary lead in terms of growth performance and haematology in broiler chickens [14]. In view of the fact that elimination of lead contamination of poultry feed and water is mostly unsuccessful, especially during feed composition and water supply coupled with very little data on how effects of dietary lead consumption on broilers in terms of carcass yield and organs weight could be prevented. Therefore this study was undertaken to evaluate the potential of AA supplementation in reversing the negative effects of lead as it may affect carcass yield and organ weight in broiler chickens.

MATERIALS AND METHODS

Experimental Diets: Six isonitrogenous and isocalories experimental diets were formulated as shown in Tables 1 and 2. Ascorbic acid (Vitamin C, 100mg tabs, Michelle Laboratories Limited, Enugu, Nigeria) and lead as lead acetate (Lab Tech Chemicals, India) were used. The control diet, diet I contained neither lead acetate (LA) nor ascorbic acid (AA) (0mg LA/kg feed and 0mg AA/kg feed), while diets II, III, IV, V and VI contained 200mg LA/kg feed at a fixed level. Also, diets II contained 0mg AA/kg feed. Other diets, i.e. diets III, IV, V and VI contained: 50; 100; 150 and 200mg AA/kg feed respectively. These inclusions were done for both broiler starter and finisher rations.

Experimental Birds: For the purpose of this experiment, 120 day-old broiler chicks were randomly assigned to six treatment groups with two replicates of 10 birds each. Six isonitrogenous and isocalories experimental diets were compounded and fed to birds *ad libitum;* T_1 (control group) received basal diet I (0mg LA and 0mg AA/kg feed), T_2 received diet II (200mg LA/kg feed and 0mg AA/kg feed), T_3 received diet III (200mg LA and 50mg AA/kg feed), T_4 received diet IV (200mg LA and 100mg

Table 1: Composition of Experimental Diet; Broiler Starter

	Percentage composition (%)					
Ingredients	Diet I	Diet II	Diet III	Diet IV	Diet V	Diet VI
Maize	55.00	55.00	55.00	55.00	55.00	55.00
Groundnut Cake	30.00	30.00	30.00	30.00	30.00	30.00
Fish Meal	3.00	3.00	3.00	3.00	3.00	3.00
Blood Meal	3.00	3.00	3.00	3.00	3.00	3.00
Wheat Offal	5.00	5.00	5.00	5.00	5.00	5.00
Bone Meal	0.80	0.80	0.80	0.80	0.80	0.80
Limestone	2.50	2.50	2.50	2.50	2.50	2.50
Salt	0.25	0.25	0.25	0.25	0.25	0.25
Vitamin Premix	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10	0.10
Total	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*
Test materials						
Lead Acetate (mg/kg)	-	200	200	200	200	200
Ascorbic Acid (mg/kg)	-	-	50	100	150	200
Calculated values						
Crude Protein (%)	23.39	23.39	23.39	23.39	23.39	23.39
Metabolizable Energy (kcal/kg)	2881.21	2881.21	2881.21	2881.21	2881.21	2881.21

Table 2: Composition of Experimental Diet; Broiler Finisher

Ingredients	Percentage composition (%) Diet I	Diet II	Diet III	Diet IV	Diet V	Diet VI
Maize	62.00	62.00	62.00	62.00	62.00	62.00
Groundnut Cake	30.00	30.00	30.00	30.00	30.00	30.00
Fish Meal	1.00	1.00	1.00	1.00	1.00	1.00
Blood Meal	1.00	1.00	1.00	1.00	1.00	1.00
Wheat Offal	3.00	3.00	3.00	3.00	3.00	3.00
Bone Meal	0.80	0.80	0.80	0.80	0.80	0.80
Limestone	1.50	1.50	1.50	1.50	1.50	1.50
Salt	0.25	0.25	0.25	0.25	0.25	0.25
Vitamin Premix	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10	0.10
Total	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*
Test materials						
Lead Acetate (mg/kg)	-	200	200	200	200	200
Ascorbic Acid (mg/kg)	-	-	50	100	150	200
Calculated values						
Crude Protein (%)	20.89	20.89	20.89	20.89	20.89	20.89
Metabolizable Energy (kcal/kg)	2981.79	2981.79	2981.79	2981.79	2981.79	2981.79

AA/kg feed), T_5 received diet V (200mg LA and 150mg AA/kg feed) and T_6 received diet VI (200mg LA and 200mg AA/kg feed). The experiment lasted seven weeks.

Data Collection

Tissues Harvest: At the end of the feeding trials, the birds were starved overnight to stabilize them; two birds were randomly sampled from each replicate, weighed and slaughtered using Halaal/Koscher slaughtering method. The slaughtered birds were quickly dressed; carcass parts and some selected organs were carefully and completely harvested. The weights of these parts were expressed as percentage of live weight of the birds.

Statistical Analysis: Data obtained were subjected to none-way ANOVA and significant means were compared with post hoc test, using GraphPad InStat 3 software. Results were considered to be statistically significant when P < 0.05.

RESULTS

Results of the live weight, dress weight and carcass parts of broilers were shown in table 3. Average live weight of experimental birds ranged from 1.58-2.05kg/bird, while dressed weights ranged from 1.27-1.67kg/bird. Dietary lead treatment without AA in T_2, significantly *(P<0.05)* reduced the live and dressed weights of broiler.

Table 3: Carcass Characteristics of Experimental Birds

Parameters	Dietary treatments T_1	T_2	T_3	T_4	T_5	T_6
Live weight (kg/bird)	2.05^a	1.58^b	1.95^a	1.76^a	1.81^a	1.73^a
Dressed weight (kg/bird)	1.67^a	1.27^c	1.55^a	1.47^b	1.43^{bc}	1.32^{bc}
Average Carcass and Organ Weights as Percentage of Live Weight (%)						
Wings	7.98	7.41	8.62	8.78	7.92	8.35
Breast	17.15^a	14.37^b	16.01^a	19.26^a	17.14^a	17.11^a
Thigh	11.64^b	10.98^b	12.09^b	14.25^a	13.44^b	11.99^b
Drumstick	8.71^a	8.49^b	9.01^a	9.95^a	8.56^a	9.39^a
Lumbar	11.20	10.76	9.67	11.96	11.9	10.23
Liver	2.12	2.96	2.33	2.21	2.38	2.42
Spleen	0.14	0.23	0.32	0.14	0.14	0.21
Kidney	0.58^b	0.79^b	0.59^b	0.85^a	0.91^a	0.92^a
Gizzard	1.92^b	3.04^a	1.96^b	2.13^b	2.87^a	2.38^{ab}
Proventriculus	0.65^a	0.66^a	0.44^b	0.61^a	0.69^a	0.64^a

abc: Means on the same row with different superscripts are significantly different (P<0.05)

Also, birds in T_2 had significantly *(P<0.05)* reduced weights of the breast, thigh and drumstick, while changes in their other organs were not significant *(P>0.05)*. For live weight, breast and drumstick, birds on treatments: T_1, T_3, T_4, T_5 and T_6 were significantly similar. Weight of liver was numerically highest (2.96%) in T_2, (lead treated group) and weight of spleen was numerically highest (0.32%) in T_3; (group treated with 200mg LA/kg feed and 50mg AA/kg feed). Also, significant increases in the weight of kidney follow a progressive increase in AA supplementations. T_4, T_5 and T_6 had significantly higher weights of kidney (0.85%, 0.91% and 0.92%) respectively when compared with the negative control (0.58%) (T_1). The weight of gizzard was significantly higher in T_2 (3.04%) and T_5 (2.87%). Weight of proventriculus significantly ranged from 0.44% in T_3 to 0.69% in T_5 and lowest in T_4 (0.44%).

DISCUSSION

At the end of the study, birds in T_2 had a significantly lower live weight and dressed weight when compared with the negative control. This might be attributed to metabolic disorders associated with lead, such as inhibition of enzymes involved in the haem synthesis and the oxidase system resulting in loss of cellular functions and tissue damage [12] in this group of birds.

Dietary lead exposure of 200mg LA/kg feed without AA supplementation significantly *(P<0.05)* reduced the weights of the breast, thigh and drumstick. This could have been caused by the negative significant effect of lead on live weight and dressed weight sequel to poor feed intake, interruption of nutrient metabolism and absorption. However, Koong *et al.* [15] and Bond *et al.* [16], reported heavier values of organs (liver) which probably indicate hypertrophy due to toxicity. This was corroborated in this study as absent of AA in T_2 resulted in numerical highest weight of liver and significant *(P<0.05)* highest weight of gizzard. Meanwhile, treatment with 50mg AA/kg feed illustrated a significant effect on the kidney, gizzard and proventriculus that is comparable with those of control group. T_4, T_5 and T_6, i.e. 100; 150 and 200mg ascorbic acid/kg feed respectively had significantly higher weights of kidney. This could have been caused by increased solubility and absorption of lead due to ascorbic acid, with consequent renal hypertrophy as a result of renal hyper-function in a bid to remove absorbed lead from the body.

CONCLUSION

Results obtained from this study revealed that, AA supplementation at varying doses may be of prophylactic and therapeutic importance to broilers exposed to dietary lead poisoning. This is because AA played a significant ameliorative role on lead induced toxicity by way of improving the reduced carcass yield and organ weight back towards normal.

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