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SERUM CORTICOSTERONE, PERFORMANCE AND SLAUGHTER TRAITS OF COBB500 BROILER CHICKENS FED LYCOPENE-SUPPLEMENTED DIETS DURING HEAT PERIOD

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ABSTRACT

Poultry farmers in the tropics suffer great loss in broiler production to extreme environmental heat, especially at post brooding stage when broilers would have grown more feathers and their metabolic heat generation rate is high. This study therefore investigated ameliorative effects of lycopene supplement on growth performance, slaughter traits and serum corticosterone level of COBB500 broiler chickens managed during heat period. A total of 120 birds were selected at 4th week of rearing and allotted into a control and three experimental groups designated as T1, T2 and T3 (treatments 1, 2, and 3), each in 3 replicates. The four groups were fed the same starter diet for 4 weeks and then differently on finisher diets supplemented with lycopene at 0mg/kg feed (control), 5mg/kg (T1), 10mg/kg (T2), 15mg/kg (T3) for 3 weeks. Data obtained were analysed using ANOVA. Results showed that at 5mg/kg supplementation level, lycopene significantly ($p<0.05$) decreased serum concentration of corticosterone and thigh muscle weight. Although, most performance indices were not statistically different except feed intake, the best feed conversion ratio was obtained at T3 (15mg/kg) lycopene supplementation. Therefore, at 5mg/kg feed, lycopene can be supplemented in diets to reduce the serum corticosterone level in COBB500 broiler chickens managed under hot climate.

Key words: *Performance, COBB500 broilers, corticosterone, lycopene, heat period.*

INTRODUCTION

Hot environments (internal and external) is a challenge to finisher broiler chickens reared in the tropics. This is due to overwhelming effects of both the high ambient temperature (external) and the high metabolic heat generation (internal) by the broilers during finisher stage of production. These heat combinations exceed the reported thermo-neutral ranges of 12°C to 26°C (Holik, 2009), and could sometimes exceed the thermoregulatory capacity of broilers, thus inducing heat stress. Some of the adverse effects of extreme heat in broilers are; reduced feed intake, poor feed conversion ratio, poor weight gain and growth performance and sometimes high mortality (Mack *et al.*, 2013). The adverse effects of heat on performance usually devour broiler farmers of their expected gain. An estimated $128 to $165 million annual economic loss to heat stress has been reported in the US poultry industry (St-Pierre *et. al.* 2003). Supplementation of various antioxidants in feeds or waters, among other measures, are being used as means of ameliorating the negative effects of heat in birds. Lycopene is a potent antioxidant naturally available in tomato, watermelon, pink guava and pawpaw (Ambreen *et al.*, 2013). Its synthetic form has been widely used as supplement in diet-based therapy in reducing oxidative damage of DNA and lymphocytes (Alshatwi *et al*., 2010). Lycopene has numerous double bonds which are responsible for its scavenging ability and protection against free radicals (Naz *et al.*, 2014). Its singlet oxygen quenching ability has been reported to be better than α- and β-carotene, lutein and α tocopherol (Perkins-Veazie and Collins, 2004). It is efficiently absorbed owing to its lipophilic characteristics (Rao and Agarwal, 1999). Its assimilation is dependent on chylomicron micelles mediated mechanism which facilitates its movement from gastrointestinal tract towards body tissues (Naz *et al.*, 2013). However, dietary supplementation of lycopene in managing heat stress in chickens has not been well reported. This

study therefore, investigated ameliorative effects of lycopene supplement on performance, slaughter traits and corticosterone levels of COBB500 broiler chickens.

MATERIALS AND METHODS

Experimental design and diets

One hundred and twenty COBB500 broiler chicks of mixed sexes were used for this study. They were randomly allotted into 4 groups (**control, T1, T2, and T3**), and fed the same starter diet for 4 weeks. But they were fed differently on finisher diets supplemented with lycopene at 0, 5, 10, and 15mg/kg feed representing the control, T1, T2 and T3 respectively for 3 weeks. They were reared in an open pen under deep litter system and vaccinated accordingly. The lycopene was purchased from Neolife Products® through jumia.com.ng and was delivered to Sokoto State. The diet compositions are presented below.

Table 1. Composition of both the starter and the finisher experimental diets

Feedstuffs	Starter diet (0-4 weeks)	Finisher diets supplemented with lycopene (mg/kg feed)			
		Control (0mg/kg)	T1 (5mg/kg)	T2 (10mg/kg)	T3 (15mg/kg)
Maize	42.03	50.34	50.34	50.34	50.34
Soybean	12.66	8.55	8.55	8.55	8.55
GNC	25.31	17.11	17.11	17.11	17.11
Wheat offal	15.00	19.00	19.00	19.00	19.00
Bone meal	2.50	2.50	2.50	2.50	2.50
Limestone	1.50	1.50	1.50	1.50	1.50
Salt	0.25	0.25	0.25	0.25	0.25
Lysine	0.20	0.20	0.20	0.20	0.20
Methionine	0.25	0.25	0.25	0.25	0.25
*Premix	0.30	0.30	0.30	0.30	0.30
Lycopene (mg/kg = ppm)		0.0	0.0005	0.001	0.0015
Total	**100.00**	**100.00**	**100.0005**	**100.001**	**100.0015**
Calculated values					
Crude protein (%)	23.00	19.00	19.00	19.00	19.00
Energy (kcal/kg)	2753.73	2753.73	2780.21	2780.21	2780.21

*Premix to supply Vitamin D (2,000mg), Vitamin K_3 (2,000mg), Vit. B_{12} (10,000mg), pantothenic acid (10,000mg), niacin (26,000mg), folic acid (1,000mg), biotin (100,000mg), choline (150,000mg), manganese (10,000mg), zinc (50,000mg), cobalt (250mg), iron (40,000mg), copper (6,000mg), iodine (500mg), selenium (100mg).
KEY: GNC: Groundnut cake, **T1, T2, T3:** Treatments 1, 2 and 3, **mg/kg:** milligram per kilogram, **ppm:** part per million

Sample collection

At the end of the 7th week of the study, six (6) chickens per group were selected and about 1ml of blood was sampled from each bird through the wing veins into plain bottles. They were allowed to clot and then were centrifuged to obtain serum for hormone analysis. Corticosterone hormone was assayed using Accu-bind® Elisa Kits sourced from California, USA, as instructed by the manufacturer.

Data collection, analysis and presentation

Obtained data were subjected to analysis of variance (ANOVA) at 5% probability using GraphPad prism InStat version 3.0 statistical software (d, Software, Inc., San Diego, CA USA). The data were presented in tables and bar chart.

RESULTS AND DISCUSSIONS

The result of serum corticosterone levels in the birds is presented in fig. 1. The highest level of corticosterone (2.23ng/mL) was recorded in the control group. This conforms with Attia *et al.*, (2009) report that release of corticosterone is stimulated by stress conditions. At 5mg/kg feed supplementation, lycopene significantly ($p<0.05$) decreased serum corticosterone level in T1 compared to other groups.

However, the effect was not sustained beyond 5mg/kg lycopene-feed supplementation, as the dosage of lycopene increases, corticosterone levels also increases. This may be attributed to the reduced feed intake recorded at 10 mg/kg and 15mg/kg lycopene supplementation levels which consequently might have reduced lycopene intake and bioavailability. More so, the decreased feed intake in T2 and T3 groups might have also reduced dietary protein available in the stomach of the birds for passage of lycopene carotenoids in the gut. According to Jian *et al.* (2005), lycopene carotenoids need to form a complex with proteins within the acidic pH of stomach, to facilitate its passage through intestinal lumen. Then, the resultant lycopene-protein complex breakdown and lycopene joins chylomicron in blood stream to reach target tissue via hepatic pathway (Jian *et al.*, 2005; Gao *et al.*, 2008). This result may imply that more lycopene carotenoids were bioavailable to COBB500 broiler chickens fed at 5mg/kg supplementation compared to other groups. Therefore, further studies focusing on lower dosages and bioavailability of the supplement may be necessary to ascertain these assumptions.

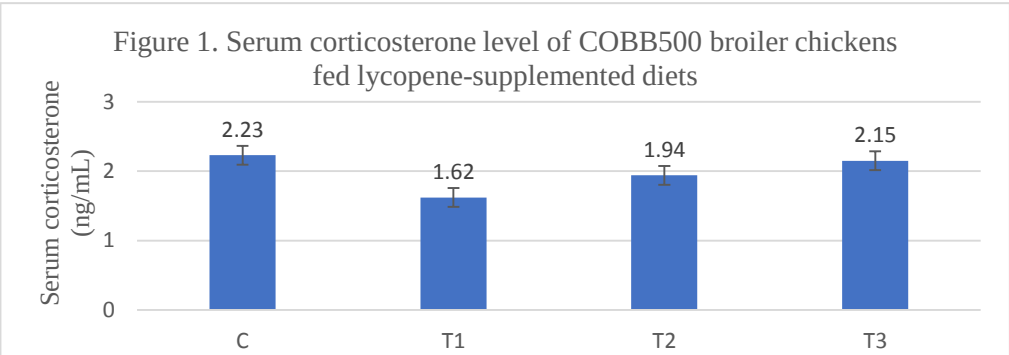


Figure 1. Serum corticosterone level of COBB500 broiler chickens fed lycopene-supplemented diets

The result of performance indices of the broiler chickens is presented in table 2. Feed intake improved significantly ($p<0.05$) in groups T1 (2.50kg) and T3 (2.23kg) but was statistically similar in the control and T2 groups (Table 2). It is important to note that the least corticosterone level was also recorded at 5mg/kg feed supplementation (fig. 1). It may be inferred that the supplement is most effective at this dosage and may explain why there was improved feed intake in group T1. Weight gain varies across the groups ranging between 0.8kg and 1.10kg in control and T3 groups respectively. Feed conversion ratio (FCR) was best in group T3 (2.03) compared to other treatment groups (T2: 2.5 and T3: 2.31) and the control (2.62). And as an index of measuring performance, lowest value implies excellent conversion of feed to muscle.

Table 2. Performance indices and serum corticosterone level of COBB500 broiler chickens fed lycopene-supplemented diets

Performance indices (kg/b)	**Control (0mg/kg)**	**T1 (5mg/kg)**	**T2 (10mg/kg)**	**T3 (15mg/kg)**	**SEM**
Mean initial weight/bird at 4 weeks	0.95	0.94	0.94	0.93	0.01
Mean final weight/bird at 7 weeks	1.75	1.94	1.85	2.03	0.05
Mean weight gain	0.80	1.00	0.91	1.10	0.12
Mean feed intake within week 5-7	2.10^{a}	2.50^{c}	2.10^{a}	2.23^{b}	1.10
Feed Conversion Ratio (FCR)	2.62	2.5	2.31	2.03	-- --

abc: means in the same row with different superscripts are significantly ($p<0.05$) different.

Table 3 presents the result obtained on slaughter traits of the COBB500 broiler chickens fed lycopene-supplemented diets. There was no significant difference in all organs and parts across the groups except. thigh muscles. This may be due to effects of restricted movement and more resting normally exhibited by birds as part of behavioral measures of managing heat condition (Mack *et al.*, 2013). There was also no

gross pathologic lesion observed on the organs and carcasses, indicating that the supplement is safe and non-toxic to organs and muscles of the birds.

Table 3. Slaughter traits of COBB500 broiler chickens fed lycopene-supplemented diets

Parameters (g)	Control	T1	T2	T3	SEM
Live weight	1750	1940	1850	2030	0.05
Dress weight	1600	1800	1700	1850	-
% Dress weight	91.42	92.78	91.89	91.13	-
Thigh	2.76[a]	3.27[b]	3.81[b]	4.74[b]	1.10
Wings	1.10	1.08	1.06	1.10	0.01
Neck	1.09	1.10	1.27	1.05	0.65
Breast muscle	5.00	5.53	5.83	5.79	0.03
Lumber	3.81	2.76	2.65	2.63	0.01
Gizzard	1.14	1.16	1.14	1.10	0.05
Heart	0.11	0.12	0.12	0.12	0.01
Small intestine	0.16	0.18	0.23	0.17	0.12
Large intestine	0.17	0.16	0.18	0.16	0.03
Spleen	0.10	0.11	0.11	0.10	0.01
Proventriculus	0.13	0.12	0.12	0.12	0.01
Liver	0.12	0.14	0.12	0.15	0.12

CONCLUSION AND RECOMMENDATIONS

Poor heat dissipation with negative heat impacts usually occur in broiler chickens at the finisher stage of production when feed higher in energy is commonly fed, more metabolic heat is generated by the birds and enough feathers have been grown in almost all body parts of the birds. As a measure of ameliorating the negative effects of heat on birds, antioxidants like lycopene is recommended at 5mg/kg lycopene-feed supplementation.

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