Performance Characteristics and Carcass Quality of Broilers Chicks under High Stocking Density and Vitamin E Supplemented Diets

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Abstract
Two hundred and seventy day-old broiler chicks were randomly divided into five treatments in three replicates of 10 birds.m^{-2} (0.1 m^2.$bird^{-1}$) in Treatment 1 (positive control) and Treatment 2 (negative control), 3, 4 and 5 with 20 birds.m^{-2} (0.05 m^2.$bird^{-1}$). Treatments 1 and 2 had no dietary Vitamin E supplementation while Treatments 3, 4 and 5 had Vitamin E supplementation at 50, 100 and 150 mg.kg^{-1} respectively. At the end of the experiment, carcass characteristics: cold shortening (CS), thermal shortening (TS), cooking loss (CL), shear force (SF) and water holding capacity (WHC) of the birds were determined. There were no significant changes in the weight gain and final weight of the birds fed the different diets but the feed conversion ratio (FCR) was highest in the birds fed dietary Treatment 2 (3.29) compared to those on Vitamin E supplemented diets. The WHC was not significantly different in the raw (58.43-59.43%) and cooked meat (59.02-59.51%) for all the treatments. The birds in Treatment 2 had the highest CS (3.50%) compared to those on Vitamin E supplemented diets (2.45-2.55%). The SF of the birds was not significantly different in all treatments with mean values at 3.35-3.60%. The implication from the results is that broiler chicks can be stocked up to 20 birds.m^{-2} without adverse effects provided the diet is supplemented with 100 mg.kg^{-1} Vitamin E.

Keywords: Stock density, Vitamin E, carcass quality, broilers

IntroductionPoultry farmers often increase stock density in the desire to attain higher profit but this always results in the building up of heat that consequently leads to heat stress. Several methods are available to alleviate the effect of high environmental temperatures and increased stocking density on the performance of poultry. Since it is expensive to cool animal buildings, such methods are mainly focused on the manipulation of the diets. In this regard, Vitamin E is used in the poultry diet because of the identified benefits of Vitamin E supplementation to laying hens during heat stress (Bollengier-Lee *et al.,* 1999; Sahinet *al.,* 2001) and also because Vitamin E levels are reduced during heat stress (Feenster, 1985; Boliengier-Lee *et al.,* 1999; Sahinet *al.,* 2002).

Vitamin E has been recognized as an essential nutrient for growth and health of all species of animals. The diverse roles of Vitamin E are due to its involvement on nutritional myopathy, prostaglandin biosynthesis and immune responsiveness (Lin *et al.,* 1996). One of the most important properties of Vitamin E is its antioxidant function. When animals are fed diets rich in unsaturated fatty acids which are susceptible to peroxidation, the Vitamin E deficiency is augmented. Supplementation of animal diets with tocopherols increases the content of this natural antioxidant in animal food products and prevents lipid peroxidation in broiler meat (Ajuyah *et al.,* 1993). Therefore, the objective of this study was to evaluate the effects of optimal dose of Vitamin E supplementation on the performance and carcass quality characteristics in broilers reared under increased stocking density

Materials and Methods

Three hundred (300) day-old Arbor Acre strain of broiler chicks procured from a reputable hatchery in Ibadan, Nigeria were brooded together for one (1) week under the same feeding regime. Two hundred and seventy (270) started chicks were selected and used for this study carried out at the Teaching and Research Farm of the University of Ibadan,

Ibadan for four (4) weeks. The birds were randomly divided into five treatments at 30 birds in Treatment 1 (positive control) while Treatments 2 (negative control), 3, 4 and 5 contained 60 birds. The birds in Treatment 1 were further divided into three replicates of 10 birds each while the birds in Treatments 2 to 5 were subdivided into 20 birds per replicate. All the pens were bedded with wood-shaving litter and equipped with feeders and waterers.

The birds fed dietary Treatment 1 had a spacing of 10 birds.m^{-2} (0.1 m^2.$bird^{-1}$) without Vitamin E supplementation (positive control) while those in Treatment 2 had a stocking density of 20 birds.m^{-2} without Vitamin E supplementation (negative control) while Treatments 3-5 had Vitamin E supplemented diets at 50, 100 and 150 $mg.kg^{-1}$ respectively. The basal compositions of the experimental diets are shown Table 1.

Feed intake and weight gain data were recorded on weekly basis while feed conversion ratio was calculated from values obtained from feed intake and weight gain. At the end of the feeding trial, nine (9) birds were randomly chosen from each treatment (3 birds per replicate) and slaughtered for carcass quality evaluation. The design of the experiment was completely randomized design (CRD). All data collected were subjected to statistical analysis of variance (ANOVA) procedure of SAS, 1999.

Table 1: Gross composition of experimental diets (% DM)

Ingredients	T1 (Positive control)	T2 (Negative control)	T3 (50 $mg.kg^{-1}$ Vit. E	T4 (100 $mg.kg^{-1}$ Vit. E	T5 (150 $mg.kg^{-1}$ Vit. E
Maize	58.00	58.00	58.00	58.00	58.00
Groundnut cake	21.00	21.00	21.00	21.00	21.00
Palm kernel cake	1.00	1.00	1.00	1.00	1.00
Fish meal	2.00	2.00	2.00	2.00	2.00
Soybean meal	14.60	14.60	14.60	14.60	14.60
Bone meal	2.40	2.40	2.40	2.40	2.40
Premix	0.30	0.30	0.30	0.30	0.30
Salt	0.30	0.30	0.30	0.30	0.30
Lysine	0.30	0.30	0.30	0.30	0.30
Methionine	0.20	0.20	0.20	0.20	0.20
Vitamin E (mg/kg)	0.00	0.00	50.00	100.00	150.00
Total	100.00	100.00	100.00	100.00	100.00
		Calculated analysis			
Crude Protein (%)	23.00	23.00	23.00	23.00	23.00
Metabolizable energy (kcal/kg)	3019.27	3019.27	3019.27	3019.27	3019.27
Crude fibre (%)	3.30	3.30	3.30	3.30	3.30
Calcium (%)	1.05	1.05	1.05	1.05	1.05

Results

There were no significant differences (P> 0.05) in the weight gain and final weight of birds fed the different dietary treatments as shown in Table 2. Nevertheless, the highest final weight (0.78 kg) and highest weight gain (0.64 kg) were recorded in birds on Treatment 5 and Treatment 4, respectively. The highest feed intake (1.91 kg) was recorded in birds on Treatment 2 and lowest (1.58 kg). The feed conversion ratio (FCR) was influenced by the dietary treatments. The least FCR (2.45) was observed in birds on Treatment 4 while highest FCR (3.72) was observed in birds on Treatment 5.

Table 3 shows the effects of stocking density and different levels of Vitamin supplementation on carcass quality of broiler chickens. There were no significant differences (P> 0.05) in the water holding capacity (WHC) of the raw and cooked, and shear force (SF) among all the treatments. The highest WHC (raw) at 59.43% was observed in birds on treatment 1 and the lowest (raw) at 58.43% was observed in birds on treatment 2 while highest and lowest WHC (cooked) was 59.51% and 59.02% in birds fed diet treatments 2 and 1, respectively. The cold shortening (%), cooking loss (%) and thermal shortening (%) were

influenced (P> 0.05) by the treatments. The highest cooking loss (40.02%) was observed in birds on diet treatment 2 and lowest (37.05%) was observed in birds on diet treatment 5. The highest cold shortening (3.50%) was recorded in birds on treatment 2 and lowest (2.45%) in birds on treatment 3. The highest thermal shortening (37.61%) was recorded in birds on treatment 5 and lowest (26.56%) in birds on treatment 2.

Table 2: Effect of stocking density and different levels of Vitamin supplementation on performance characteristics of broiler chicks

Parameters	T1 (Positive control)	T2 (Negative control)	T3 (50mg/kg Vit. E)	T4 (100mg/kg Vit. E)	T5 (150mg/kg Vit. E)	SEM
Initial weight(kg)	0.12	0.10	0.10	0.11	0.11	
Final weight (kg)	0.75	0.68	0.68	0.68	0.78	0.13
Weight gain (kg)	0.63	0.58	0.57	0.64	0.43	0.43
Feed intake (kg)	1.59^{c}	1.91^{a}	1.76^{b}	1.58^{c}	1.60^{c}	1.03
Feed conversion ratio	2.52^{a}	3.29^{b}	3.08^{b}	2.45^{a}	3.72^{b}	1.56

Discussion

Kennedy *et al.* (1992) examined the productivity of 168 broiler birds fed diets containing either 50 mg/kg or 180 mg/kg dietary Vitamin E and found that at the greater level of supplementation, the productivity was 8.4% greater as a result of improvement in FCR and higher average weight gain. Similarly, Sahin and Kucuk (2001) observed that dietary Vitamin E inclusion resulted in greater performance of Japanese quails reared under heat stress (34°C). The Vitamin E supplementation was able to ameliorate the effect of heat stress that would have resulted from the overstocking. The low FCR in the vitamin supplemented group is also in agreement with Villar *et al.* (2002) that the feed efficiency increased statistically with vitamin supplementation.

Meat quality evaluation is important in production (Barbera and Tossone, 2006) and carcass quality is the measure of carcass palatability and acceptability to the consumer (Renand and Fisher, 1997). The cooking loss was observed for birds fed diets supplemented with Vitamin E. This shows that the anti-oxidation effect of the Vitamin E resulted in the reduction of cooking loss. This will, however, affect the optimal eating quality and this is of great importance to the catering industry. The cooking loss depends on the raw meat quality as reported by Asalyng *et al.* (2003) and meat with high cooking loss will have lower WHC as shown in this result. The WHC values fall within the range of 42.22-66.97% reported for scalded, single and conventionally dressed rabbit carcasses (Omojola and Adeshinwa, 2006).

The WHC in birds fed the negative control diet was reduced because the birds were subjected to stress which might have increased the water loss by panting resulting into a reduction in the space within the myofibrillar protein network with a consequent decrease in water lowering the WHC. The differences in shear force may represent changes in the elastic characteristics of the connective tissue of different muscles which had different mechanical properties (Robertson *et al.,* 1984). The non-significant differences between the values observed in the results could be a function of age of the birds (4 weeks); the birds were still growing with the muscles not fully developed such that the Vitamin E supplementation did not produce any noticeable change.

Conclusion

In this study, Vitamin E supplementation at 100 $mg.kg^{-1}$ with increased stock density (0.05 $m^{2}.bird^{-1}$) compared favourably with birds on the positive control (0.1 $m^{2}.bird^{-1}$) in the efficiency of feed utilization. The stocking density of broilers chicks can be up to 20 birds. m^{-2} provided the diet is supplemented with 100 $mg.kg^{-1}$ Vitamin E.

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