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Performance Characteristics and Carcass Quality of Broiler Chicks Under High Stocking Density Fed Vitamin E Supplemented Diet

[1]O.A. Adebiyi, [2]O.A. Adu and [1]M.D. Olumide
[1]Department of Animal Science, University of Ibadan, Ibadan, Nigeria
[2]Department of Animal Science, Federal University of Technology, Akure, Nigeria

Abstract: About 270 days old Arbor acre strain of broiler chicks were used for this research. The birds were randomly divided into five treatment groups of 10 birds m^{-2}/replicate (0.1 m^2 per bird) in treatment 1 (positive control) while those in treatments 2 (negative control) and 3-5 had 20 birds/m^2/replicate (0.05 m^2 per bird). Birds fed dietary treatment 1 and 2 had no supplementation with vitamin E whereas birds on dietary treatments 3-5 had 50, 100 and 150 mg kg^{-1} vitamin E supplementation, respectively. All treatments were replicated three times. At the end of the 4 weeks of 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 dietary treatments. However, the Feed Conversion Ratio (FCR) revealed that birds on dietary treatment 2 had the highest significant value of 3.29 compared to those on vitamin E supplemented diets. No significant different was observed in the WCH of both raw (58.43-59.43%) and the cooked meat (59.02-59.51%) for all the treatments. Birds fed dietary treatment 2 (negative control) had the highest significant ($p<0.05$) CS value of 3.50% compared to its counterparts on vitamin E supplemented diets with values ranging from 2.45-2.55%. No significant difference was observed in the SF of the birds in all the treatment with mean value ranging from 3.35-3.60%. In conclusion, broiler chicks could be stocked up to 20 birds m^{-2} only if the diet is supplemented with 100 mg kg^{-1} vitamin E.

Key words: Stock density, vitamin E, carcass quality, broilers, stress, nutritioned, Nigeria

INTRODUCTION

Stress in broiler production is not only restricted to heat (high ambient temperature) but also physiological stress (as a result of increasing stocking density), nutritional stress (imbalance in the nutrient requirement) and vaccination stress, etc.

Increasing stocking density of broilers is a management practice used for reducing cost associated with labour, housing and equipments. However, over-crowding of broilers can lead to reductions in performance (Shanawany, 1988).

Broiler performance and health can be influenced by very high stocking density (Webster, 1990), thereby it is important to ensure that adequate floor space is available for each bird (Al-Homidan, 2001). If the stocking density is too high, the temperature may rise dangerously since, there will be more metabolic heat being added to the house air than was planned for.

Poultry farmers often increase stock density with the aim of increasing profit but this always result in the build up of heat and consequently leading to heat stress. Several methods are available to alleviate the effect of high environmental temperature and increased stocking density on performance of poultry. Since, it is expensive to cool animal buildings such methods are focused mostly on the dietary manipulation.

In this respect, vitamin E is used in the poultry diet because of the reported benefits of vitamin E supplementation to laying hens during heat stress (Whitehead *et al*., 1998; Bollengier-Lee *et al*., 1999; Sahin *et al*., 2001), also because of the fact that vitamin E levels is reduced during heat stress (Feenster, 1985; Whitehead *et al*., 1998; Bollengier-Lee *et al*., 1999; Sahin *et al*., 2001, 2002).

Vitamin E has been recognized as an essential nutrient for growth and health of all species of animals (McDowell, 1989). The diverse roles of vitamin E are due to its involvement in nutritional myopathy, prostaglandin biosynthesis and immune responsiveness (Lin *et al*., 1996). Asghar recorded improvements in animal performance when pigs were supplemented with 100 mg vitamin E/kg of feed. One of the most important properties of vitamin E is its antioxidant function. When animals fed

Corresponding Author: O.A. Adebiyi, Department of Animal Science, University of Ibadan, Ibadan, Nigeria

diets rich in unsaturated fatty acids which are susceptible to peroxidation the vitamin E deficiency is augmented (McDowell, 1989). 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). Vitamin E is known to be a lipid component of biological membranes and is considered a major chain-breaking antioxidant (Halliwell and Gutteridge, 1989). Vitamin E is mainly found in the hydrocarbon part of membrane lipid bilayer towards the membrane interface and in close proximity to oxidase enzymes which initiate the production of free radicals (Putnam and Comben, 1987; McDowell, 1989; Packer, 1991).

Vitamin E, therefore, protects cells and tissues from oxidative damage induced by free radicals (Gallo-Torres, 1980). Sahin and Kucuk (2001) observed that supplemental vitamin E significantly alleviated the heat stress-related decrease in performance suggesting additional vitamin E supplementation into diets may be necessary under heat stress conditions in Japanese quails.

Supplementing vitamin E to broilers is also important to human health in terms of consuming healthier poultry meat products. Therefore, the objective of this study was to evaluate the effects of optimal dose of vitamin E supplementation on performance and carcass quality characteristics in broilers reared under increased stocking density.

MATERIALS AND METHODS

Total of 270 days old Arbor acre strain of broiler chicks were used for this research. The study was carried out at the Teaching and Research Farm of the University of Ibadan, Ibadan for a period of four weeks. The birds were randomly divided into five treatment groups of total of 30 birds in treatment 1 (positive control) while those in treatments 2 (negative control) and 3-5 had 60 birds treatment^{-1}. Birds in treatment 1 were further sub-divided into three replicates with 10 birds per replicate while their counterparts in treatments 2-5 were subdivided into 20 birds per replicate. All pens were bedded with a wood-shavings litter and equipped with feeders and waterers. Birds fed dietary treatment 1 had a spacing of 10 birds m^{-2} (0.1 m^2 per bird) without vitamin E (dl-α-tocopheryl acetate) supplementation (positive control) while those in treatment 2 had a stocking density of 20 birds m^{-2} without vitamin E (negative control).

However, birds on dietary treatments 3-5 had a stocking density of 20 birds m^{-2} (0.05 m^2 per bird) supplemented with 50, 100 and 150 mg kg^{-1}, respectively. Performance data (feed intake, weight gain and feed conversion ratio) were taken weekly. At the end of day 28, 9 birds randomly chosen from each treatment (3 birds per each replicate) were slaughtered for carcass quality evaluation. The design of the experiment was Completely Randomized Design (CRD). Data taken were subjected to statistical Analysis of Variance (ANOVA) procedure of SAS (1999). The basal composition of the experimental diets are shown in Table 1.

Table 1: Gross composition of experimental diet (percentage dry matter basis)

Ingredients (kg)	TI (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
Soyabean meal	14.60	14.60	14.60	14.60	14.60
Bone meal	2.40	2.40	2.40	2.40	2.40
Premix (broiler starter)	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^{-1})	0.00	0.00	50.00	100.00	150.00
Total	100.00	100.00	100.00	100.00	100.00
Calculated nutrient					
Crude protein (%)	23.00	23.00	23.00	23.00	23.00
Metabolisable energy (kcal kg^{-1} ME)	3,019.27	3,019.27	3,019.27	3,019.27	3,019.27
Crude fibre (%)	3.30	3.30	3.30	3.30	3.30
Calcium (%)	1.05	1.05	1.05	1.05	1.05

T1 = 10 birds m^{-2}; T2 = 20 birds m^{-2}; T3 = 20 birds m^{-2}+50 mg kg^{-1} vitamin E; T4 = 20 birds m^{-2}+100 mg kg^{-1} vitamin E; T5 = 20 birds m^{-2} +150 mg kg^{-1} vitamin E

RESULTS AND DISCUSSION

There were no significant changes in the weight gain and final weight of birds fed the different dietary treatments (Table 2). The feed intake increased significantly in birds fed T2 (1.91 kg) (negative control) compared to their counterpart on vitamin E supplementation (1.58-1.60 kg). However, FCR of birds fed diets T1 (2.50), T4 (2.77) and T5 (2.50) were not significantly ($p<0.05$) different. Table 3 shows the effect of the vitamin E supplementation on the meat quality of broiler. No significant different was observed in the WCH of both raw (58.43-59.43%) and the cooked meat (59.02-59.51%). Birds fed dietary treatment 2 (negative control) had the highest significant ($p>0.05$) CS value of 3.50% compared to those on vitamin E supplemented diets (2.45-2.55%).

No significant ($p<0.05$) difference was observed in the SF of the birds in all the treatment with mean value ranging from 3.35-3.60%. In the present study, vitamin E supplementation at 100 mg kg^{-1} with increased stock density (0.05 m^2 per bird) compared favourably with birds on the positive control (0.1 m^2 per bird) in the efficiency of feed utilisation. The increase in the FCR of birds on diet 2 (negative control) could be attributed to the increase in stress resulting from competition for feed and water, increase of house temperature, microbial activity and ammonia production. Kennedy *et al.* (1992) examined the productivity of 168 broiler flocks fed diets containing either 50 or 180 mg kg^{-1} dietary vitamin E. The researchers reported that at the greater level of vitamin E supplement, productivity was 8.4% greater as a result of improvements in both FCR and higher average weight gain.

Similarly, Sahin and Kucuk (2001) found that dietary vitamin E inclusions resulted in a greater performance in 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. Ushakova *et al.* (1996) showed that dietary supplements of vitamin E can modify gene expression induced by heat shock *in vivo* and have a protective role against oxidative stress by enhancing the level of endogenous antioxidants and inducing Heat shock protein *(Hsp)-70* gene expression. Organisms respond to elevated temperatures and physiological stresses by an increase in the synthesis of Heat shock proteins (Hsp) or stress proteins. The researchers further reported that vitamin E supplementation in heat stressed broiler house resulted in better performance, perhaps due to increased Hsp synthesis. The cells with increased Hsp exhibit tolerance against the additional stress.

The low FCR in vitamin supplemented group is also in agreement with the earlier reports of Villar *et al.* (2002) who reported a statistical increase in feed efficiency with vitamin supplementation. Contrary to the result obtained, Al- Homidan (2001) revealed no significant difference in broiler performance due to stocking density. However, this study showed that increase stocking density reduced

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

	Dietary treatments					
Parameters (kg)	TI (Positive control)	T2 (negative control)	T3 (50 mg kg^{-1} vitamin E)	T4 (100 mg kg^{-1} vitamin E)	T5 (150 mg kg^{-1} vitamin E)	SEM
Initial weight	0.12	0.10	0.10	0.11	0.11	
Final weight	0.75	0.68	0.68	0.68	0.78	0.13
Weight gain	0.63	0.58	0.58	0.57	0.64	0.43
Feed intake	1.58^c	1.91^a	1.76^b	1.58^c	1.60^c	1.03
Feed Conversion Ratio (FCR)	2.50^b	3.29^a	3.03^a	2.77^b	2.50^b	1.56

$^{a-c}$Means on same row with different superscripts differ significantly ($p<0.05$); T1 = 10 birds m^{-2}; T2 = 20 birds m^{-2}; T3 = 20 birds m^{-2} + 50 mg kg^{-1} vitamin E; T4 = 20 birds m^{-2}+ 100 mg kg^{-1} vitamin E; T5 = 20 birds m^{-2}+150 mg kg^{-1} vitamin E

Table 3: Effect of stocking density and different levels of vitamin E supplementation on carcass quality broiler chicks

	Dietary treatments					
Parameters (kg)	TI (Positive control)	T2 (negative control)	T3 (50 mg kg^{-1} vitamin E)	T4 (100 mg kg^{-1} vitamin E)	T5 (150 mg kg^{-1} vitamin E)	SEM
WCH (%) (RM)	59.43	58.43	59.21	59.14	59.21	4.32
WCH (%) (CM)	59.02	59.51	59.10	59.07	59.34	5.14
Cold shortening (%)	2.55^b	3.50^a	2.45^b	2.50^b	2.50^b	0.51
Cooking loss (%)	38.04^b	40.02^a	37.64^b	37.56^b	37.05^b	2.11
Shear force (kg)	3.60	3.50	3.45	3.30	3.35	0.21
Thermal shortening (%)	31.50^b	26.56^c	32.56^b	34.21^b	37.61^a	1.54

$^{a-c}$Means on same row with different superscripts differ significantly ($p<0.05$); T1 = 10 birds m^{-2}; T2 = 20 birds m^{-2}; T3 = 20 birds m^{-2}+50 mg kg^{-1} vitamin E; T4 = 20 birds m^{-2}+100 mg kg^{-1} vitamin E; T5 = 20 birds m^{-2}+150 mg kg^{-1} vitamin E; WCH = Water Holding Capacity; RM = Raw Meat; CM = Cooked Meat feed utilisation in broiler as shown by birds fed dietary treatment 2 (0.05 m^2 per bird without vitamin E supplement). Meat quality evaluation is important in improving meat production (Barbera and Tassone, 2006) and carcass quality is the measure of carcass palatability and acceptability to the consumer (Renand and Fisher, 1997). The cooking loss is a combination of liquid and soluble matter lost from meat during cooking. At increasing centre temperatures, the water content of the meat has been shown to decrease and the fat and protein content to increase indicating that the main part of cooking loss is water (Heymann *et al*., 1990).

Thus water loss is of economic concern because it affect weight loss along distribution chain during cooking (Okunbanjo *et al*., 2003). The least cooking loss was observed for birds fed diets supplemented with different levels of vitamin E, this therefore, shows that the antioxidation effect of the vitamin E resulted into the reduction in the 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 Aaslyng *et al.* (2003), meat with high cooking loss will have lower Water Holding Capacity (WCH) as shown in this result.

The WHC fell within the ranges of 42.22-66.97% values reported by Omojola and Adesehinwa (2006) for scalded, singed and conventionally dressed rabbit carcasses. 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 consequence decrease in water lowering the WHC. Differences in shear force may represent changes in the elastic characteristics of the connective tissue of different muscle which had different mechanical properties as reported by Robertson *et al.* (1984). The non- significant values observed in the result could be a function of age of the birds (4 weeks), the birds are still growing and the muscles are not fully developed thus the vitamin E supplementation did not produced any noticeable change.

CONCLUSION

The stocking density of broilers chicks could be up to 20 birds m^{-2} (0.05 m^2 per bird) only if the diet is supplemented with 150 mg kg^{-1} vitamin E.

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