EFFECT OF DIETARY INCLUSION OF VITAMIN C ON PERFORMANCE AND PHYSIOLOGICAL RESPONSE OF GROWING PULLETS

B. S. ADEDEJI*S, O. AOGUNWOLE*, F. O. JEMISEYE*, A. O. MOSURO*, AND I. A. OLUDOYI*

**Agricultural Biochemistry and Nutrition Unit, Department of Animal Science, University of Ibadan, Nigeria*

Correspondence: bs.adedeji@gmail.com; +2347037686167

ABSTRACT

The effect of dietary supplementation of vitamin C on point of cage pullets was investigated in a 7-week trial. Point of cage Bovan Brown pullets (n=96) aged 12 weeks were randomly allotted to three treatments of four replicates and eight birds per replicate. Birds were initially on a basal ration for three weeks followed by supplementation with 0 mg/Kg Vitamin C (T1), 300 mg/Kg vitamin C (T2) and 600 mg/Kg vitamin C (T3) with feed and water provided *ad libitum*. Ambient Temperature (AT), Relative Humidity (RH) and Temperature Humidity Index (THI) were monitored. Weight gained (WG), Feed Intake (FI), livability were recorded, Feed conversion ratio (FCR) was determined while panting rate and Rectal temperature (RT) were taken. The AT (29.00±1.49 °C), RH (71.93±0.27 %), and THI (26.90±1.28) were the documented environmental parameters. Feed intake (0.89, 0.87, 0.88 for birds on T1, T2 and T3, respectively) and livability (93.8, 96.9, 96.9 for birds on T1, T2 and T3, respectively) were not influenced ($P>0.05$) by the treatment. The WG of birds on T1 (0.36) was similar ($P>0.05$) to those on T3 (0.42) but lower ($P<0.05$) from those on T2 (0.47). The FCR of birds on T2 and T3 were significantly lower ($P<0.05$) compared to birds on T1. Panting rate of birds on T3 (207.80) was lower ($P<0.05$) compared to similar higher ($P>0.05$) panting value recorded for birds on T1 (231.75) and T2 (225.00) while RT of birds on T3 (41.9) was lower compared to those on T1 (41.52). Vitamin C supplementation improved WG by pullets. Feed conversion ratio was lowered while panting rate and rectal temperature were lowered in growing pullets given supplemental vitamin C.

Keywords: Point of cage pullets, Rectal temperature, Vitamin C, Temperature humidity index.

INTRODUCTION

Heat stress remains a serious impediment to increased poultry production in the tropics. Heat stress in poultry is prompted by combinations of environmental temperature and humidity that prevent the bird's thermoregulatory process from effectively dissipating heat produced during metabolism (Webster, 1983). The thermoneutrality of chickens is between 18-22□C (Charles, 2002) and the temperature in the hot humid tropics of Ibadan, Nigeria, often times exceed this (Majekodunmi *et al.*, 2013). Outside the thermo neutral zone, chickens become uncomfortable and as such place a limitation on the attainment of their intrinsic genetic potential thus a resultant reduction in live weight gain, feed intake, feed efficiency, quality of eggs coupled with increased mortality (Demir *et al.*, 1995; Bollengier *et al.*, 1999). Nutritional intervention such as the use of vitamin C to manage stress in poultry is an option. Several authors (Abioja *et al.*, 2005; Ogunwole *et al.*, 2012; Majekodunmi *et al.*, 2013) have demonstrated the role of supplemental vitamin C in the alleviation of stress in poultry. Similarly, there have been reported increased feed intake (Sahin and Kuck, 2001) and improved FCR (Onu, 2009 and Blaha *et al.*, 2010) by dietary inclusion of vitamin C for poultry. Despite avalanche of reports on importance of vitamin C and stress mitigation in poultry production, there still remains the gap of appropriate supplemental levels as well as inconsistencies on the effects in poultry. Most studies on the alleviation of stress

in poultry have been devoted to broilers and laying chickens with little information on its effect on growing pullets. This study was therefore conducted to investigate the performance and physiological response of growing pullets given diets supplemented with graded levels of vitamin C.

MATERIALS AND METHODS

Point of cage Bovan Brown pullets (n=96) aged 12 weeks were purchased from a reputable farm and allotted to three dietary treatments of four replicates and eight birds per replicate in a completely randomized design. Birds were initially raised on an iso-caloric and iso-nitrogenous basal diet for the first three weeks after which the diets were supplemented with vitamin C. Detail of the basal experimental diet is shown in Table 1. Treatment 1 is the control with no inclusion of vitamin C, Treatment 2 had 300 mg/Kg Vitamin C and Treatment 3 had 600 mg/kg Vitamin C. Feed was offered daily and left over weighed weekly to calculate feed intake. Weight gain was measured on a weekly basis while feed conversion ratio was calculated. Mortality was recorded against each replicate; Panting rate was determined by counting the number of breaths made in 1 minute; Rectal temperature (RT) was measured by inserting the probe of a digital thermometer into the rectum of selected birds; ambient temperature and relative humidity were monitored using digital thermo-hygrotherms mounted within the pen house while Temperature Humidity Index (THI) was calculated according to Zulovich and DeShazer (1990) using the formulae THI layers = 0.6 Tdb + 0.4 Twb.

RESULTS AND DISCUSSION

The AT (29±1.49 °C) and RH (71.93±0.27 %) were perpetually high during the trial. High temperature and low humidity (32 °C and 40 % RH) have been reported to be well tolerated by birds while high temperature and high humidity (32 °C and 90 % RH) were problematic (Lesson and Summers, 2005). Thermo-neutral zone (TNZ) is the range of ambient temperature which does not affect regulatory changes in metabolic heat production or evaporative heat loss in birds (Kingma *et al.*, 2012). Dei and Bumbie (2011) reported that diurnal ambient temperature fluctuations usually exceed the TNZ of chickens thus resulting in heat stress. The THI values (26.90±1.28) obtained in this study were outside the TNZ of chickens thus further suggesting that they were thermally stressed during the rearing period. Performance of growing pullets fed dietary supplementation of Vitamin C is shown in Table 2. Final weight, weight change, feed intake and livability values were within the range of 1.19 (T1) to 1.26 (T2); 0.36 (T1) to 0.41 (T3); 0.87 (T2) to 0.89 (T1) and 93.8 (T1) to 96.9 (T3), respectively. These parameters were however not influenced ($P>0.05$) by dietary inclusion of vitamin C while weight change and FCR were significantly different ($P<0.05$) across the treatments with values ranging from 0.36 (T1) to 0.47 (T2) and 1.89 (T2) to 2.48 (T1) respectively.

The insignificance ($P>0.05$) in final weight observed in this study was in agreement with Tuleun *et al.* (2011) and Cifti *et al.* (2015) in Japanese quail and laying chickens, respectively but was contrary to the observation of Oso *et al.* (2013) and Ogunwole *et al.* (2013) in turkey and broiler chickens fed supplemental vitamin C, respectively. Significant difference ($P<0.05$) was observed in weight change of the birds as birds on T1 had higher ($P<0.05$) weight change, though similar ($P>0.05$) to those on T3 but was different ($P<0.05$) from those on T2. The similarity observed in birds on T1 and T3 could be that the supplementation of vitamin C beyond 300mg was in excess of dietary need of the pullets thereby interfering with weight gained by pullets. Contrary to earlier reports (Demir *et al.*, 1995; Sahin and Kuck, 2001) that feed intake increased with vitamin C inclusion. Observations in this study conformed to reports (Oniseibo and Alu, 2006; Onu, 2009) that dietary supplementation of vitamin had no effect on feed consumption. The FCR of birds on T2 (1.89) and T3 (2.09) were similar ($P>0.05$) but was significantly lower ($P<0.05$) compared to values obtained for birds on T1 (2.48). This observation agreed with earlier documentations (Onu, 2009;

Blaha *et al.*, 2010) on improved FCR with supplementation of vitamin C in poultry diets. Although, other authors (Ogunwole *et al.*, 2013; Lohakhare *et al.*, 2015; Majekodunmi *et al.*, 2015) did not observe any improvement of FCR in broilers. Livability (%) of birds on the different treatments was similar (P>0.05) though, there was a relative improvement with increasing levels of vitamin C inclusion which was in line with earlier reports (Skyes 1977; Kafri and Cherry, 1984; David and Brake, 1985) on reduction in the incidences of mortality in chickens on diets with supplemental vitamin C in hot environments. Table 3 shows the physiological response of pullets to dietary vitamin C supplementation. At temperature beyond 27 °C, chickens become intensely under stress and would resort to a means of dissipating heat from its body. In this study, panting rate in birds on T3 (207.8) was significantly lower (P<0.05) compared to those on T2 (225) and T1 (231), thus emphasizing the importance of vitamin C in the alleviation of heat stress in poultry although values obtained were however higher than 100 to 151 breaths/min observed by Nascimento *et al.* (2012) in Avian and cobb strains of broilers exposed to heat. The body temperature of domestic chickens is maintained within a relatively narrow range that is usually reflected by the upper (41.5 °C) and lower (40.5 °C) limits of a circadian rhythm (Daghir, 1995), this however fluctuates depending on the temperature of its environment (Sottnik, 2002). Rectal temperature of birds on T1 in this trial was similar to that of birds in T2 but differed significantly from those on T3. This showed that inclusion of vitamin C up to 600 mg/Kg (T3) significantly lowered rectal temperature when compared with the control. This observation supported the findings of Kutlu and Forbes (1993), though values obtained for RT in this study were within the body temperature (41-42 °C) ascribed as normal for chickens (Donkoh, 1989). Conversely, Pardue and Thaxton (1986); Genedi, (2000); Majekodunmi *et al.* (2015) observed no significant effect of supplemental vitamin C on RT of broilers exposed to high temperature.

CONCLUSION

Environmental parameters revealed that birds in this study were heat stressed. Vitamin C supplementation improved weight gain and feed conversion ratio so also were the physiological parameters observed in this study.

REFERENCES

Abioja, M. O., Osinowo, O. A., Smith, O. F., Eruvbetine D. and Abiona, J. A. (2011). Evaluation of cold water and vitamin C on broiler growth during hot dry season in SW Nigeria. *Arch. Zootec.* 60 (232): 1095-1103.

Blaha, J., Draslarova, J., and Kroesna, K. (2000). The effect of vitamin and electrolyte supplement on broiler performance under stress. *Agricultural Tropical ET Subtropical.* 33: 52-58.

Bollengier-lee, S., Williams, P. E. V. and Whitehead, C. C. (1999): Optimal dietary concentration of vitamin E for alleviating the effect of heat stress on egg production in laying hens. *Br Poult. Sci.*, 1999, 40: 102-107.

Charles, D. R. (2002). Responses to the thermal environment. In: Poultry Environment Problems, A guide to solutions (Charles, D.A. and Walker, A.W. Eds.), Nottingham University Press, Nottingham, United Kingdom, pp.1-16.

Ciftci, M., Nihat, E. O. and Guler, T. (2005). Effects of vitamin E and vitamin C dietary supplementation on egg production and egg quality of laying hens exposed to a chronic heat stress. *Revue Med Vet*; 156(2):107-111.

Daghir, N. J. (1995). Poultry Production in Hot Climates. The University Press, Cambridge.

David, E. P. and Brake, J. (1985). Relationship of dietary ascorbic acid to broiler breeder performance. *Poult. Sci.*, 64: 2041-2048.

Dei, H. K. and Bumbie, G. Z. (2011). Effect of net feeding on growth performance of broiler chickens in a hot climate. *Br. Poult. Sci.* 52:82-85.

Demir, E., Öztürkcan, O., Görgülü, M., Kutlu, H. R., and Okan, F. (1995). Sicak kosullarda yumurta tavugu rasyonlarina eklenen vitamin

A ve C'nin yumurta özelliklerine etkileri. *J. Agric.* Fac. Ç.Ü., , 10 (4) : 123-132.

Donkoh, A. (1989). Ambient temperature: A factor affecting performance and physiological response of broiler chickens. *Int. J. Biometeorol.*, 33: 259-265.

Genedi, D. M. M. (2000). The role of some anti-stressors on layer performance during hot climate conditions. M.Sc., Thesis Faculty of Agriculture, Cairo University.

Kafri, I. and cherry, J. A. (1984). Supplemental as corbic acid and heat stress in broiler chicks. *Poult.Sci.*, 63(supp):125.

Kingma, B., Frijns, A. and Lichtenbalt, W. V. (2012). The thermoneutral zone: implication for metabolic studies. *Front. Biosci.* 4:1975-1985.

Kutlu H. R. and Forbes, J. M. (1993). Changes in growth and blood parameters in heat-stressed broiler chicks in response to dietary ascorbic acid. *Livestock Product Sci.*, 36, 335-350.

Lohakare, J. D., Ryu, M. H., Hahn, T.W., Lee, J. K.. and Chae, B. J. (2005). Effects of supplemental ascorbic acid on the performance and immunity of commercial broilers. *J. Appl. Poult. Res.* 14:10-19

Majekodunmi, B. C., Ogunwole, O. A. and Sokunbi, O. A. (2013). Effect of supplemental electrolyte and ascorbic acid on the performance and carcass characteristics of broiler raised during high temperature period in Nigeria. *Int. J. of Poult. Sci.* 11(2): 125-130

Majekodunmi, B. C., Ogunwole, O. A. and Sokunbi, O. A. (2015). Synergistic Effect of Electrolytes and Ascorbic Acid on Performance and Physiological Response of Broiler Birds in Hot Humid Tropics. *International Journal of Agriculture and Forestry*, 5(1): 23-29

Nascimento, S. T., Oliveira, I. J., da Silva, Mourão, G. B. de Castro, A. C. (2012). Bands of respiratory rate and cloacal temperature for different broiler chicken strains. *R. Bras. Zootec.*, 41 (5): 1318-1324.

Ogunwole, O. A., Oikeh, I. Olowe, T. O., Omotoso, R. R. and Oso, Y. A. A. (2012). Blood profile of broiler starter chickens as affected by diets supplemented with graded levels of ascorbic acid. *Proc. 17th Ann. Conf. Animal Science Assoc. of Nigeria. International Conference Centre, Opposite Radio House, Area 8, Abuja,* September 9-13 pp. 203-206. Eds. Akpa, G. N., Dairo, F. A. S., Bawa, G. S., Solomon, I. P., Amaefule, K. U., Odunsi, A. A. and Ladokun, A. O.

Ogunwole, O. A., B. C. Majekodunmi, T. O. Olowe, and Olumide, M. D. (2013). Meat quality and bone characteristics of broiler chickens fed diets supplemented with graded levels of ascorbic acid. Proc. 38th Conf. Nig. Soc. Anim. Prod. Rivers State Univ. of Science and Tech. 17-20 March, pp. 774-776. Eds. B. M. Oruwari, J. P. Alawa, U. I. Oji, O. J. Owen and O. S. George.

Onu, P. N. (2009). Growth performance, carcass characteristics and economic benefits of supplemental ascorbic acid on broiler starters exposed to heat stress. ARPN Journal of Agricultural and Biological Science vol. 4, No. 5, September 2009. ©2006-2009 Asian Research Publishing Network (ARPN). www.arpnjournals.com

Oso, A. O., Oke, O. E., Abioja, M. O., Abiona, J. A., Agbodo, G. A. and Adebowale, T. O. (2013). "Growth and Physiological Response of Local Turkey (Meleagris gallopavo) Offered Dietary Vitamin C". *Pacific Journal of Science and Technology.* 14(2):441-447.

Pardue, S. L. and J. P. Thaxton. (1986.) Ascorbic acid in poultry: A review. *World's Poult. Sci. J.* 42:107– 123.

Sahin, K. and O. Kuck. (2001). "Effect of Vitamin C and Vitamin E on Performance, Digestion of Nutrient and Carcass Characteristics of Japanese Quails Reared under Chronic Heat Stress (34c)". *J. Anim. Physiol. Anim. Nutr.*, 85:335-342. 21. Tuleun, C.D., A.Y. Adenkola, and T. Afele.

Sottnik, J. (2002). Climatical factors and their effect on production in animal housing. In: ASAE Annual International Meeting/ CIGR XVth World Congress; Chicago, Illinois, USA: ASAE editors.

Sykes, A. H. (1978) Vitamin C for poultry: some recent research. In: Proceedings of the Roche Symposium London, pp. 5–15.

Tuleun, C. D., Adenkola, A. Y. and Afele, T. (2011). Effect of dietary ascorbic acid supplementation on the performance of Japanese (Coturnix coturnix japonica) quails in a tropical environment. *Journal of Animal & Plant Sciences.* Vol. 10, Issue 2: 1268-1275.

Webster, A. J. F. (1983). Nutrition and the thermal environment in nutritional physiology of farm animals, J.A.F. Rook and P.C. Thomas (Eds.), New York, Longman; pp : 639-669.

Zulovich, J. M. and J. A. DeShazer. (1990). Estimating egg production declines at high environmental temperatures and humidifies. ASAE Paper No. 90-4021. St. Joseph,Mich.: ASAE.

Table 1: Gross composition (%) of basal diet fed to grower pullets'

Ingredient	% (Kg)
Maize	50.80
Soybean meal	18.00
Wheat offal	27.85
Oyster shell	1.00
Bone meal	1.6
Premix	0.25
Salt	0.30
DL-Methionine	0.10
L-lysine	0.10
Calculated Nutrients	
ME (Kcal/kg)	2751.27
Crude Protein (%)	16.87
Crude Fibre (%)	4.55
Methionine (%)	0.37
Lysine (%)	0.98
Calcium (%)	1.07
Available Phosphorus (%)	0.42

Table 2: Performance of growing pullets fed dietary supplementation of vitamin C

Parameters	T1	T2	T3	SEM
Feed intake	0.89	0.87	0.88	0.004
Initial weight	0.83	0.81	0.80	0.01
Final weight	1.19	1.28	1.23	0.03
Weight gain	036^{b}	0.47^{a}	0.42^{ab}	0.01
FCR	2.48^{a}	1.89^{b}	2.09^{b}	0.09
Livability (%)	93.8	96.9	96.9	1.78

$^{a, b}$: means in the same row with different superscripts are significantly different ($p<0.05$). FCR Feed conversion ratio

Table 3: Physiological response of growing pullets fed dietary vitamin C supplementation

Parameters	T1	T2	T3	SEM
Rectal Temperature (°C)	41.9^{a}	41.70^{ab}	41.52^{b}	0.07
Panting rate	231.75^{a}	225.00^{a}	207.8^{b}	3.54

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