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EFFECT OF VITAMIN C SUPPLEMENTATION ON EGG QUALITY AND PRODUCTION TRAITS OF JAPANESE QUAIL (*Coturnixcoturnix japonica*)

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Abstract
An experiment was conducted to study the effects of Vitamin C (L-ascorbic acid) supplementation on egg quality and production traits of Japanese quail (*Coturnixcoturnix japonica*). Forty-eight laying Japanese quails were selected at 9 weeks from an existing flock and allotted to 4 treatment groups of 12 birds per group with 3 replicates in each group. Birds in treatment 1 served as the control group and were fed a basal diet (19% crude protein; 2700 Kcal/kg) with no vitamin C supplementation. Birds in treatment 2 were fed basal diet + 250 PPM vitamin C supplementation. Birds in treatment 3 were fed basal diet + 500 PPM vitamin C supplementation, while birds in treatment 4 had basal diet + 750 PPM vitamin C supplementation. Birds fed Vitamin C supplemented diets had significantly higher ($P<0.05$) feed intake (FI), feed conversion ratio (FCR) and hen day production (HDP). Birds that were fed with 500 PPM vitamin C supplementation had the best FCR and HDP. Average egg weight (AEW), egg width (EW), yolk height (YH) and haugh unit (HU) were also significantly ($P<0.05$) higher in Vitamin C supplemented groups than the control group. Cost benefit ratio analysis showed that birds on 500 PPM vitamin C supplementation had the highest returns on investment. The results of this study suggest that the supplementation of diet of laying Japanese quail at 500 ppm in hot tropical weather had beneficial effects on egg production, egg quality and on the benefit: cost ratio.
Keywords: egg quality, heat stress, Japanese quail, Vitamin C

Introduction

The tropical environment is characterised by high ambient temperature which depresses bird's performance and productivity through reduced feed intake, decreased nutrient utilization, growth rate and egg quality which lead to economic losses in poultry (Roberts and Wall, 1998, Sahin*et al.*, 2009). Heat stress occurs in animals when there is an imbalance between heat production within the body and its dissipation. Reactive oxygen species (ROS) are constantly generated *in vivo* during metabolism and may cause oxidative stress when their level exceeds the threshold value. To combat oxidative stress, the body innately produces antioxidants such as vitamin C in their kidneys to quench these free radicals called ROS. However, endogenous ascorbic acids is insufficient to meet the birds' requirement during heat stress (Abidin and Khatoon, 2013). Farmers on their part usually respond to the negative impact of heat stress on poultry production by cooling the livestock buildings. To ameliorate the high cost involved in cooling animal buildings and boost livestock performance during heat stress, researchers have employed dietary manipulations such as supplementation of feed and or water with non-enzymatic antioxidants like vitamin C, vitamin E, zinc, and chromium picolinate (Kassim and Norziha, 1995; Sahin and Sahin, 2001; Sahin*et al.*, 2003a; Lohakare*et al.*, 2004 and Ajakaiye*et al.*, 2011).

Several studies have shown a positive effect of dietary vitamin C supplementation on different poultry production traits (Cheng *et al.*, 1990; Zapata and Gerrat, 1995; Sahin and Kucuk 2001; Sahin*et al.*, 2003a and Sahin*et al.*, 2003b). For instance, Zapata and Gerrat (1995) reported the positive effects of Vitamin C in maintaining egg production and egg shell quality of White leghorn hens during heat stress. Cheng *et al.* (1990) also reported the positive effects of Vitamin C on livability and performance of laying hens. Vitamin C has proven beneficial when added to feed and water fed to broiler chicken during the summer stress (Lohakare*et al.*, 2004). Onol*et al.*, (2003) had reported an improvement in livability, egg production, feed consumption, egg weight and egg shell weight when Japanese quails reared under heat stress were expose to vitamin C supplementation. In the contrary, BardakçiogLu*et al.* (2005) observed that vitamin C supplementation had no significant effect on feed consumption, feed

conversion and egg shell thickness in the diet of laying Japanese quail.

The recent increased interest in Japanese quail for commercial egg and meat production in tropical countries such as Nigeria underscore the need for studies on impact assessment and mitigation strategies to alleviate the negative impact of high environmental temperature on quail performance.

A growing wealth of scientific evidence in farm animals have suggested that responses to the same nutritional regime varies from one environment to the other and there is therefore the need to avoid the one-size fits all approach in nutrients substitution from one region to the other. This study therefore aims to evaluate the effect of dietary vitamin C supplementation on egg production and quality traits of Japanese quail in Nigeria.

Materials and Methods

Experimental site:

The study was carried out at the poultry section of the Teaching and Research farm, Faculty of Agriculture, University of Ilorin, Ilorin, Nigeria. The study area is located between the rainforest of the Southwest and Savannah grassland of the Northern Nigeria. It lies within 8° 30' 0" North, 4° 33' 0" East at an altitude of s305m, 1001' above sea level. Its day temperature and annual rainfall is between 600-1200 mm per annum and 33-37^0 C, respectively. Ilorin has relative humidity of 75-80% and 65% in wet and dry seasons, respectively.

Experimental Birds and Diets:

Forty-eight, female Japanese quails at nine (9) weeks old were randomly selected from an existing flock at the Teaching and Research farm of the University of Ilorin. The birds were housed individually in cages and allocated to four dietary treatment groups based on vitamin C inclusion level. Each treatment group had 3 replicate with 4 birds per replicate. A basal ration (Table 1) of 19.5% crude protein and 2800Kcal/kg was formulated based on requirements for laying quails. Birds in treatment 1 (control) were fed with basal diet (19.5% crude protein; 2800Kcal/kg) with no vitamin C supplementation. Birds in treatment 2 were fed with basal diet with 250 ppm vitamin C supplementation. Birds in treatments 3 and 4 were fed with basal diet and 500 ppm and 750 ppm vitamin C supplementation, respectively. Feed and water was provided *ad libitum* for the 8 weeks period of the experiment.

Data collection and statistical analysis:

Data on daily egg production were collected from 9th to 17th weeks of age. Eggs were collected at the same time each day, and daily egg numbers were divided by the number of birds to obtain the daily egg production (%). Data on feed intake, mortality rate and feed conversion ratio (grams of feed/dozen egg) were also collected. Twelve (12) eggs were randomly selected per treatment for weekly egg analysis. The eggs were weighed individually (in grams) using a sensitive electronic scale to determine the mean egg weight. Egg length, egg width, shell weight, yolk weight, yolk index, albumen index, albumen height, shell thickness and the haugh unit were determined according to the methods of Kul and Seker (2004).Egg length and height were determined in centimeters using a vernier caliper and micrometer screw gauge. The haugh unit (HU) was determined using the formulae;

$$HU = 100\log[H - \sqrt{G(30w^{0.37} - 100)} + 19]$$

Where H = Albumen height, W = Egg weight

All data collected were subjected to a one way analysis of variance procedure of SPSS Version 16 (SPSS, 2008).

Table 1: Composition of the Basal diet

Feed Ingredients	Quantity (%)
Maize	55.00
Soya bean meal (SBM)	24.00
Fish meal	2.00
Groundnut cake (GNC)	4.00
Wheat offal	6.00
Bone meal	2.00
Limestone	6.00
Salt	0.30
Vitamin premix	0.25
Methionine	0.30
Lysine	0.15
Total	**100.00**
Nutrients composition on dry matter basis:	
Crude protein (%)	19.55
Metabolizable energy ME (Kcal/kg)	2810.60
Calcium	2.99
Phosphorus	0.80
Crude fibre	3.46

Results and Discussion

The effects of dietary vitamin C supplementation on egg production, feed intake

and feed conversion ratio (FCR) of Japanese quail are shown in Table 2. Feed intake, FCR and hen day production were significantly better (P<0.05) in Japanese quail that were fed with vitamin C supplemented diets than in the control group. Feed intake was not significantly different (P>0.05) among treatment groups receiving vitamin C supplementation, though treatments 2 and 3 had the highest value of 26.55g/bird/day. Feed conversion ratio in terms of grams of feed/dozen egg also showed no significant difference (P>0.05) among groups receiving vitamins C inclusion. Treatment 3 with 500 ppm however had the least amount of 347.31g/dozen eggs while the control group had the highest value of 357.11g/dozen eggs. Hen-day production was significantly higher (P<0.05) in birds receiving 500 ppm vitamins C supplementation with a value of 93.50% HDP. HDP was least in the control group (86.14%) while treatments 2 and 4 had values of 91.22% and 90.82%, respectively. Mortality rate however showed no significant difference (P>0.05) among the four treatment groups.

The significant improvement recorded in feed intake and egg production in the present study as a result of dietary vitamin C supplementation is in agreement with the findings of other researchers (Lohakare*et al*., 2004, Onol*et al.*, 2003, Okan*et al*., 1999 and Sahin*et al.*, 2003b). The significant improvement in feed intake and feed conversion ratio obtained in this study is similar to the reports of Nazligul*et al.*, (2001) who reported a feed intake of 26.40g/bird/day in their study on production traits and egg quality characteristics of Japanese quail. Onol*et al*. (2003) also reported improvement in feed consumption (23.15g/bird/day) and (354g/dozen eggs) in their report on Japanese quail fed diets with vitamin C supplementation. An earlier work by Okan (1999) showed a higher value of 31.33g/bird/day for feed consumption. BardakçiogLu*et al*. (2005) however reported a lower FCR with quails on 500 ppm of vitamin C having the least value of 274.95g/dozen eggs.

The HDP obtained in this study for quails with vitamins C inclusion was higher than values reported by several authors (Okan, 1999, BardakçiogLu*et al*., 2005, Onol*et al.*, 2003). BardakçiogLu*et al*. (2005) reported lower values of 82.54-86.43% while Okan (1999) reported HDP of 82.69%, which was close to a value of 83.8% reported by Onol*et al.* (2003). Sahin*et al.* (2003b) reported a reduced HDP value of 75.3%. Livability values were numerically similar to the value reported by BardakçiogLu*et al*. (2005) for quails fed diet supplemented with 150 ppm vitamin C.

Table 2: Effects of Vitamin C Supplementation on Performance of Laying Japanese quail.

Vitamin C inclusion Level	0ppm	250ppm	500ppm	750ppm
Hen day production (%)	86.14 ± 1.22^{a}	91.22 ± 0.54^{bc}	93.50 ± 0.36^{c}	90.82 ± 0.44^{b}
Feed Intake (g/bird/day)	26.24 ± 0.04^{a}	26.55 ± 0.05^{b}	26.55 ± 0.02^{b}	26.53 ± 0.01^{b}
FCR (g/dozen egg)	357.11 ± 2.96^{b}	347.31 ± 1.19^{a}	346.02 ± 1.78^{a}	348.86 ± 2.37^{a}
Mortality Rate (%)	5.31 ± 1.04	4.27 ± 1.09	4.34 ± 1.16	5.38 ± 1.07

FCR represents Feed Conversion Ratio, $^{a-c}$ Means in the same row having different superscript differs significantly, (P<0.05).

Table 3 shows the effect of vitamin C supplementation on egg quality traits of Japanese quail. Average egg weight, egg width, yolk weight, yolk height, albumen height and haugh unit were significantly higher (P<0.05) in quails receiving vitamin C supplementation than those in the control group. Egg length, shell weight, yolk width, yolk index, albumen weight and shell thickness however showed no significant differences (P>0.05) among treatment means. The beneficial effect of vitamin C supplementation on egg quality parameters agrees with the findings of Sahin*et al.*, (2003b), Kassim and Norziha (1995) and Ajakaiye*et al.* (2011).

The mean egg weight obtained from each of the treatment groups in the present study were higher (10.79-11.48g) than the 9.63- 9.89g range that was reported by BardakçiogLu*et al*. (2005) but similar to the 11.46g reported by Önol*et al*. (2003). Sahin*et al.* (2003b) reported the mean egg weights of 11.6g and 11.4g for quails fed supplementary vitamin C and vitamins E, respectively. Egg width was similar (2.28cm) in all treatment groups receiving vitamin C supplementation and significantly

higher (P<0.05) than the control group (2.11cm). Egg shell weight though not significantly different (P>0.05) among treatment means were numerically higher in birds receiving vitamins C than in the control group. The values for egg shell weights ranged from 1.15 – 1.34g. The egg shell weights in the present study were similar to the values reported by Sahin*et al.* (2003b) but higher than the results reported by Nazligul*et al.* (2001) and BardakçiogLu*et al*. (2005). This is however expected since the egg weight in the present study is higher than that reported by the last two authors. Yolk weight was significantly higher (P<0.05) in treatment groups receiving vitamin C inclusion with treatment 3 having the highest value of 3.90g. Similarly, yolk height was significantly higher (P<0.05) in birds receiving vitamin C in their diets with birds on 750ppm vitamin C supplementation having the highest value of 11.47mm. Albumen height was highest (5.85mm, P<0.05) in birds receiving 500ppm vitamin C supplementation.

Shell thickness was not significant different (P>0.05) among treatment means, however it was numerically higher in birds receiving vitamin C supplementation. The mean for shell thickness are in agreement with values reported in literatures for quail egg shell thickness (Nazligul*et al.*, 2001, Sahin*et al.*, 2003b, BardakçiogLu*et al*., 2005). BardakçiogLu*et al*. (2005) had reported values ranging from 202 - 205µ while Nazligul*et al.*, (2001) reported a value of 0.206mm. Sahin*et al.* (2003b) reported a significantly higher value for shell thickness (22.1µm) in quails fed vitamin C supplemented diets than the control group. Haugh unit varied from 87.08 to 89.29 among the four treatment means. Birds receiving vitamin C inclusion in the diet had significantly higher (P<0.05) values with birds on 500ppm having the highest value of 89.29. These values correspond to the report of Sahin*et al.* (2003b) who had earlier reported a value of 90.5 in quails fed vitamin C in their diet. Dietary vitamin C supplementation has been reported to increase egg production, egg shell strength, and interior egg quality traits in stressed-laying hens (El-Boushy*et al*., 1968). Sahin*et al.* (2003b) explains the role of ascorbic acid in bone maturation and mobilization of calcium from bones which suggest its importance in egg formation.

Table 3: Effects of Vitamin C Supplementation on Some Egg Quality Traits of Japanese Quail

	Treatments			
	I	**II**	**III**	**IV**
Egg Quality Parameters:	**0ppm**	**250ppm**	**500ppm**	**750ppm**
Average Egg Weight (g)	10.79 ±0.03^{a}	11.48 ± 0.01^{d}	11.31 ± 0.04^{c}	11.12 ± 0.03^{b}
Egg length (cm)	3.02 ± 0.01	3.01 ± 0.01	3.00 ± 0.02	2.99 ± 0.03
Egg Width (cm)	2.11 ±0.06^{a}	2.28 ± 0.03^{b}	2.28 ± 0.04^{b}	2.27 ± 0.02^{b}
Egg shell weight (g)	1.15 ± 0.01	1.17 ± 0.01	1.15 ± 0.01	1.34 ± 0.02
Yolk weight (g)	3.23 ± 0.04^{a}	3.64 ± 0.05^{ab}	3.90 ± 0.07^{b}	3.81 ± 0.06^{b}
Yolk Height (mm)	10.21 ± 0.03^{a}	10.77 ± 0.08^{b}	10.92 ± 0.21^{b}	11.47 ± 0.17^{c}
Yolk Width (mm)	18.59 ± 0.02	18.52 ± 0.02	18.83 ± 0.06	18.39 ± 0.48
Yolk Index (%)	54.92 ±0.08	57.48 ± 0.49	57.97 ± 0.84	57.64 ± 3.92
Albumen Weight (g)	5.21 ±0.04	5.66 ± 0.08	5.69 ± 0.21	5.65 ± 0.21
Albumen Height (mm)	5.24 ± 0.09^{a}	5.63 ± 0.05^{ab}	5.85 ± 0.13^{b}	5.61 ± 0.22^{ab}
Shell Thickness (mm)	0.20 ±0.01	0.23 ± 0.01	0.22 ± 0.01	0.21 ± 0.01
Haugh Unit	87.08 ± 0.29^{a}	88.34 ± 0.15^{b}	89.29 ± 0.34^{b}	89.00 ± 0.31^{b}

$^{a-d}$*Means in the same row having different superscripts differs significantly (P< 0.05).*

Table 4 shows the cost benefit ratio of including vitamin C in the diet of Japanese quail. Cost benefit ratio was given as 10.17, 9.82, 9.57 and 9.89 for treatments I, II, III and IV respectively. Treatment iii with 500ppm vitamin C inclusion in the diet had the least cost benefit ratio of 9.57 among all birds receiving vitamin C inclusion while the control with no vitamin C inclusion had the highest ratio of 10.17, thus making the inclusion of vitamin C in the diet more profitable for egg production.

Table 4: Effect of Vitamin C inclusion on Cost Benefit Ratio of Egg Production in Japanese Quail.

Treatments (Vitamin C inclusion)	Cost/kg Feed	Total Feed Cost (₦)	Total Egg Income (₦)	Total Egg Income (₦)	Cost : Benefit
0ppm	72.00	17.47	1,257.84	12,366.67	10.17
250ppm	72.44	17.74	1,285.09	13,090.00	9.82
500ppm	72.88	17.65	1,286.33	13,440.00	9.57
750ppm	73.31	17.60	1,290.26	13,043.30	9.89

Conclusion

The results of this study suggest that the supplementation of vitamin C in diet of laying Japanese quail in hot tropical weather at 500 ppm had beneficial effect on egg production, egg quality traits and on the cost benefit ratio.

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