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Effect of Varying Stocking Densities and Vitamin C (Ascorbic Acid) Supplementation on Growth Performance of Japanese Quails

***[1]Olugbemi, T. S., [2]Olusola O. O and [1]Friday, T. S**

[1]Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University, Zaria, Nigeria.
[2]Department of Animal Science, Faculty of Agriculture and Forestry, University of Ibadan, Nigeria
**Corresponding author: tsolugbemi@ abu.edu.ng: +234(0)8134949302*

ABSTRACT

An experiment was carried out to assess the effect of different stocking densities and vitamin C supplementation on the performance of Japanese quails. Four Hundred and Thirty Two (432) unsexed quail birds of two (2) weeks of age were allotted randomly into nine (9) groups with 3 replicates each in a 3x3 factorial arrangement (3 stocking density levels and 3 graded vitamin C levels) with densities of 150, 120, 90 cm^2/bird (11, 16, 21 birds) and Vitamin C levels of 0mg/kg diet, 50mg/kg diet and 100mg/kg diet. During the five weeks growing trial (2- 6 weeks) parameters on performance attributes and heamatological values were obtained. The results showed that stocking density had significant effects on final weight (131.59g compared to 111.10g for the lowest), total and daily weight gain. No significance difference was observed for feed conversion ratio, age at first lay and first egg weight. Observations on haematological parameters (packed cell volume (PCV), total protein (TP), haemoglobin, red blood cell (RBC), lymphocyte, heterophil) on stocking density showed no significant differences. Vitamin C supplementation at 50mg/kg and 100mg/kg did not have any significant effect on the growth performance parameters of growing quails. Considering that stocking density at 150cm2/bird resulted in improvements with respect to final weight (30.54g/bird), daily weight gain (1.08g/bird) and daily feed intake (2.26g/bird) with or without vitamin C supplementation, it is recommended that stocking rates of quails between the ages of 2 – 6 weeks should not be below 150cm^2/bird.

Keywords— Anti-oxidants, Housing, Stress, Quail

INTRODUCTION

The Japanese quail is a domesticated economic species of poultry for commercial egg and meat production beside chickens. They are relatively small in body size, adaptable to intensive systems of poultry husbandry and also have unique characteristics for fast growth, early sexual maturity, high rate of egg production, short generation interval and short incubation period (Tuleun *et al.,* 2011). Increased productivity is an important economic goal of the poultry industry which is being threatened by climatic, physical and social stressors (Seyrek *et al.,* 2004). Anything which disrupts physiological and psychological stability of a chicken is a stressor (variation in feed intake, protein deficiency, starvation, shortage of feeding space etc.) and reaction of the stressor is termed as stress (Pande, 2002). Stress induces harmful responses that interferes with the general health, productivity and result in immunosuppression (Saxena and Pavneesh, 1997). Among the various stress factors, overcrowding is an important common stressor in poultry as it increases the exposure to disease causing organisms, poor production and growth, reduced feed efficiency, livability, and in some cases, carcass quality such as pH, Water Holding Capacity and meat color among others (Puron *et al.,* 1995; Abdel-Azeem, 2010). Studies have shown that stress factors such as environmental, physiological and social etc. cause the generation of free radicals which are often elevated to a level that overpowers tissue antioxidant defense systems thereby resulting in oxidative stress, impairment of the activity of the antioxidant and lowering the concentrations of antioxidant vitamins and minerals such as E, C, A, and Zn in serum in the body (Sahin *et al.,* 2005; Kumar et al., 2011). Studies on the histopathology of organs such as liver, heart, kidney and lungs have shown that prolonged exposure of poultry to excessive heat stress or overcrowding has resulted in organs being damaged which are seen as necrosis (organ death), lesions (wound) or enlargements of organs (Pandurang *et al.,* 2011).

Supplementation of diet or water with vitamin C has been shown to be effective in alleviating the negative effects of heat stress on birds and thereby improving their performance (Sahin *et al.,* 2003; Khanand and Sardar, 2005). Birds are normally able to synthesize adequate amounts of ascorbic acid but under stressful conditions, they cannot produce enough ascorbic acid for their metabolic needs and therefore require dietary ascorbic acid supplementation (Avci *et al.,* 2005). Vitamin C is used in the poultry diets due to its antioxidant properties, neutralizing the free radicals generated during stress (Ramnath *et al*., 2008). Poultry farmers often increase stocking density with the aim of increasing their profit but this always result in the build-up of heat and consequently leading to heat stress (Adebiyi et al., 2011), poor air quality due to Inadequate air exchange, increased ammonia, and reduced access to feed and water which brings about a reduced productivity, feed efficiency (Puron et al., 1995, Ramnath *et al*., 2008). Supplementation of diet with antioxidant vitamins (A, C and E) or minerals (zinc and chromium) have played individual roles in alleviating heat stress in poultry (Mansoub et al., 2010; Adebiyi *et al.,* 2011). This work was designed to evaluate the effect of stocking density and vitamin C supplementation on the performance and carcass characteristics of the Japanese quail on different stocking densities.

MATERIALS AND METHODS

Experimental Site

The study was conducted at the Poultry unit of Animal Science Department, Ahmadu Bello University, Zaria, Nigeria located at latitude 11° 9' 45" and longitude 7° 38' 8" E, and at an altitude of 610 above sea level (Ovimaps, 2012).

Source of the Experimental Materials

The vitamin C was obtained from Rebson Agric Enterprises, Zaria Nigeria. A total of 432 quail chicks were used for the study and purchased from the National Veterinary Research Institute (NVRI), Vom, Jos.

Experimental Design

A 3x3 factorial arrangement (3 stocking density levels and 3 graded vitamin C levels) trial in a completely randomized design (CRD) was used in this experiment with nine (9) treatments and three (3) replicates each. There were three (3) stocking densities viz 150cm^2/bird (control and optimum stocking density), 120cm^2/bird and 90cm^2/bird with three (3) graded levels of vitamin C (0mg/kg diet ,50mg/kg diet and 100mg/kg diet).

Table 1: Experimental diets of quail birds at growing phase (2-6weeks)

	Treatments (vitamin C; mg/kg)								
Ingredient	T 1 0	T 2 50	T 3 100	T 4 0	T 5 50	T 6 100	T 7 0	T 8 50	T 9 100
Maize	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00
Sorghum	10.00	10.00	10.00	10.00	10,00	10.00	10.00	10.00	10.00
Groundnut cake	33.75	33.75	33.75	33.75	33.75	33.75	33.75	33.75	33.75
Full fat soya bean meal	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.40
Maize offal	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Limestone	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
lysine	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Methionine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated nutrient									
ME(kcals/kg)	2901	2901	2901	2901	2901	2901	2901	2901	2901
Protein	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00
Ether Extract	6.84	6.84	6.84	6.84	6.84	6.84	6.84	6.84	6.84
Crude Fibre	3.55	3.55	3.55	3.55	3.55	3.55	3.55	3.55	3.55
Calcium	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42
Phosphorus	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Lysine	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Methionine	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56

T-Treatment, M.E-Metabolizable Energy. *biomix premix supplied per kg of diet: vit. A, 1000iu; vit. D3 2000iu; vit. E 23mg; vit. K 2mg; calcium pantothenate 2.5mg; vit. B12, 0.051mg; Folic acid 0.75mg; chloride 300mg; vit B1 1.8mg; vit B2 5mg; manganese 40mg; Iron 20mg; Zinc 30mg; Copper 3mg; Iodine 1mg; Cobalt 0.2mg.

Table 2: Effect of stocking density on the performance of Japanese quail growers (2-6weeks)

	Stocking density (birds/cage)			
Parameters	150cm²/bird (11)	120cm²/bird (16)	90cm²/bird (21)	SEM
Initial weight(g)	36.16	36.14	36.150	0.00
Final weight(g)	131.59^{a}	119.26^{b}	111.10^{b}	5.46
TWG(g/bird)	95.42^{a}	83.11^{b}	75.11^{b}	5.41
DWG(g/bird/bird)	3.40^{a}	2.96^{b}	2.68^{b}	0.19
TFI (g/bird)	429.58^{a}	404.16^{b}	376.5^{c}	3.72
DFI (g/bird/day)	15.34^{a}	14.43^{b}	13.44^{c}	0.13
FCR	4.54	4.92	5.06	0.12
AAFL(day)	40.88	40.44	40.77	0.33
First egg weight(g)	7.22	6.88	7.22	0.50

^{a,b,c}means with different superscript along the row differs significantly(p<0.05). SEM= standard error of the means. TWG= total weight gain. DWG= daily weight gain. TFI= total feed intake. DFI= daily feed intake. FCR= feedconversion ratio. AAFL = age at first lay. g=grams.

The dimension for the cages was 60cm×45cm×45cm (length ×breath ×height) with a floor area space of 2700cm^2. The area space for drinker and feeder was 900cm^2 and available space for birds/cage was1800cm^2.

Treatments/experimental diets

There were 9 treatments as follows: Treatment 1 (150cm^2/bird with no vitamin C supplementation); Treatment 2 (150cm^2/bird with 50mg vitamin C/kg of diet); Treatment 3 (150cm^2/bird with 100mg vitamin C/kg of diet), Treatment 4 (120cm^2/bird with no supplementation); Treatment 5 (120cm^2/bird with 50mg vitamin C/kg of diet) ; Treatment 6 (120cm^2/bird with 100mg vitamin C/kg of diet), Treatment 7 (90cm^2/bird with no vitamin C supplementation); Treatment 8 (90cm^2/bird with 50mg vitamin C/kg of diet); Treatment 9 (90cm^2/bird with 100mg vitamin C/kg of diet). The number of birds per cage for the different stocking rates was 11, 16 and 21birds/cage for 150cm^2, 120cm^2 and 90cm^2 respectively.

Management of Experimental Birds and Data Collection

Five hundred and twenty (520) unsexed quail birds were randomly allotted into nine groups (9). Feeds and water were given ad libitum. The feeds were iso-caloric and iso-nitrogenous (Table 1). The chicks were weighed at the beginning of the experiment and balanced for weights. They were thereafter weighed weekly and weight gains were obtained by subtracting the previous week weights from that of the preceding week.

Organ Evaluation

At the end of the five weeks growing trial, two birds from each replicate having representative weights for the group were slaughtered using the ritual method, de-feathered and eviscerated. The organs (heart, liver and kidney) were weighed and expressed as percentages of the live weight.

Haematological Analysis

At the end of the sixth week, 1ml of blood was obtained through the wing vein from each of 2 quails per replicate into bottles containing the anticoagulant ethylene di-amine tetra acetic (EDTA) and analyzed for packed cell

Table 3: Effect of vitamin c supplementation on the performance of Japanese quail growers (2-6weeks)

	Vitamin C levels(mg/kg)			
Parameters	0	50	100	SEM
Initial weight(g)	36.14	36.15	36.15	0.00
Final weight(g)	123.04	119.14	119.76	5.46
TWG(g/bird)	86.89	82.98	83.76	5.41
DWG(g/bird/bird)	3.10	2.96	2.99	0.19
TFI(g/bird)	401.97	396.77	411.00	10.74
DFI(g/bird/day)	14.35	14.17	14.70	0.38
FCR	4.68	4.87	4.99	0.36
AAFL(day)	40.66	40.77	40.66	0.33
First egg weight(g)	7.11	7.00	7.22	0.50

a,b,c means with different superscript along the row differs significantly(p<0.05)
SEM= standard error of the means. TWG= total weight gain. DWG= daily weight gain.
TFI= total feed intake. DFI= daily feed intake. FCR= feed conversion ratio. AAFL = age at first lay

Table 4: Interactive effect of stocking density and vitamin c on the performance of Japanese quails

	STOCKING DENSITY(birds/cage)/VITAMIN C (mg/kg)									
	150cm²/bird (11)			120cm²/bird (16)			90cm²/bird (21)			
	0	50	100	0	50	100	0	50	100	
Parameters	T1	T2	T3	T4	T5	T6	T7	T8	T9	SEM
Initial weight(g)	36.15	36.17	36.16	36.13	36.15	36.14	36.15	36.15	36.14	0.00
Final weight(g)	135.33[a]	131.02[ab]	128.41[ab]	120.59[ab]	111.10[ab]	126.08[ab]	113.20[ab]	115.51[ab]	104.79[b]	3.15
TWG (g/bird)	99.17[a]	94.85[ab]	92.24[ab]	84.45[ab]	74.94[ab]	89.94[ab]	72.05[ab]	79.16[ab]	69.12[b]	3.12
DWG (g/bird)	3.54[a]	3.38[ab]	3.29[ab]	3.01[ab]	2.67[ab]	3.21[ab]	2.75[ab]	2.82[ab]	2.46[b]	0.11
TFI (g/bird)	427.82[ab]	425.03[ab]	435.92[a]	405.45[ab]	386.92[ab]	420.31[ab]	372.63[b]	378.59[b]	378.57[b]	6.20
DFI (g/bird/day)	15.27[ab]	15.17[ab]	15.56[a]	14.43[ab]	13.81[ab]	15.01[ab]	13.30[b]	13.52[b]	13.52[b]	0.23
FCR	4.38	4.51	4.75	4.81	5.30	4.66	4.84	4.81	5.55	0.21
AAFL (d ay)	41	41	40.6	40.0	41.0	40.3	41.0	40.3	41	0.19
FEW(g)	7.00	7.00	7.66	6.66	7.00	7.00	7.66	7.00	7.00	0.29

[a,b,c]means with different superscript along the row differs significantly($p<0.05$)
SEM= standard error of the means. TWG= total weight gain. DWG= daily weight gain. TFI= total feed intake.
DFI= daily feed intake. FCR= feed conversion ratio. AAFL = age at first lay. FEW= first egg weight

volume (PCV), white blood cell (WBC), red blood cell (RBC) haemoglobin (Hb) and total protein (TP) concentration using Wintrobes Microhematocrit (Lamb, 1991). The analysis was carried out at the Clinical Pathology laboratory of the Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria.

Statistical Analysis

All the data generated were analysed using General Linear Model procedure for ANOVA. Means were separated using the Tukey's test at 5% level of significance.

The model for this study was:

$Y_{ijk} = \mu + S_i + T_j + ST_{ij} + E_{ijk}$

Y_{ijk}= record of the kth birds fed jth vitamin C supplementation on ith stocking density.

μ = overall means

S_i= effect of ithstocking density (i.e 150cm2/bird, 120cm2/bird, 90cm2/bird)

T_j= effect of jth vitamin C supplementation (i.e 0mg/Kg, 50mg/Kg, 100 mg/Kg).

ST_{ij} = interaction between ith stocking density and jth vitamin C supplementation.

E_{ijk}= random error

RESULTS AND DISCUSSION

Table 2 shows the performance of growing quails on different stocking densities. Total and daily weight gain were highest for birds from the group with 11birds/cage (150cm²/bird) and decreased as density increased to 16birds/cage (120cm²) and 21birds/cage (90cm²/bird). Total and daily feed intake was lowest among the group of birds with the highest stocking density (21birds) and increased with increased density. These findings agree with Puron *et al.* (1995) and Feddes *et al.* (2002) who reported a reduction in feed intake when stocking density increased. Final weight was significantly ($p<0.05$) higher for birds from the group with 11birds/cage (150cm²/bird) and decreased as density was increased to 16birds/cage (120cm²) and 21birds/cage (90cm²/bird) respectively. This finding is in line with the reports of (Mortari *et al.*, 2002; Dozier *et al.*, 2005) indicating significant decrease in body weight of broiler chickens as stocking density increased. This is probably due to the birds on the lowest densities having adequate spacing which provided enough access to feed and water without any restriction thereby allowing them to add more weight compared to the birds in other groups with higher densities of 16 and 21 birds respectively which caused some sort of restriction in movement and limited access to feed and water. There were no significant ($p>0.05$) differences in feed conversion ratio, age at first lay and first egg weight as a result of different stocking density levels. Better feed conversions with increased stocking density were reported by Cravener *et al.* (1992) and Bessei (1993). This is based on the assumption that moderately increased stocking density represents a mild feed restriction which usually improves feed conversion. However, some findings showed no significant difference for feed conversion ratio as stocking density increased (Waldroup *et al.,* 1992, Tayeb *et al.,* 2011). Their observations were in agreement with the findings of this study which also showed no significant difference for feed conversion ratio as stocking density increased.

The effect of varying levels of vitamin C on growth performance of quails is shown in Table 3. Results revealed that there was no significant ($p>0.05$) difference in all growth performance parameters measured (total feed intake, daily feed intake, total weight gain, daily weight gain final weight, feed conversion ratio, age at first lay). The observations obtained from this trial may be as a result of the quantity of the vitamin C supplemented which was probably low.

Table 5: Effect of stocking density on haematological parameters of Japanese quail growers

Stocking Density Levels (cm²/bird)				
Parameters	150	120	90	SEM
PCV%	60.52	57.08	61.33	3.78
Hb(g/dl)	20.155	18.99	20.40	1.26
TP(gm/dl)	4.73	4.96	4.56	0.45
RBC	10.06	9.46	10.18	0.62
Lymphocyte	88.88	83.47	86.48	3.54
Heterophil	10.52	15.63	13.171	3.31

PCV= Packed Cell Volume. TP= Total Protein. Hb= Haemoglobin. RBC= Red Blood Cell

Table 4 shows the result of interactive effect of stocking density and vitamin C supplementation at different combined levels on the growth parameters measured.

Table 6: Effect of vitamin c supplementation on haematological parameters of Japanese quail growers

Vitamin C levels(mg/kg)				
Parameters	0	50	100	SEM
PCV%	59.16	62.52	57.25	3.78
Hb(g/dl)	19.68	20.82	19.04	1.26
TP(gm/dl)	5.194	4.62	4.45	0.45
RBC	9.82	10.41	9.46	0.62
Lymphocytes	86.47	86.32	86.05	3.54
Heterophils	12.69	13.17	13.47	3.31

PCV= packed cell volume. TP= total protein. Hb= haemoglobin. RBC= red blood cell

Table 7: Interactive effect of stocking density and vitamin C supplementation on haematological parameters of Japanese quail growers

stocking density (birds/cage)/vitamin c (mg/kg)										
	150cm²/bird (11)			120cm²/bird (16)			90cm²/bird (21)			
	0	50	100	0	50	0	0	50	100	SEM
Parameters	T1	T2	T3	T4	T5	T6	T7	T8	T9	
PCV%	62.50	60.33	58.75	53.00	65.25	53.00	62.00	62.00	60.00	2.18
Hb (g/dl)	20.80	20.11	19.55	17.62	21.72	17.63	20.63	20.62	19.95	0.72
TP (gm/dl)	5.4	4.6	4.15	5.45	4.85	4.60	4.73	4.36	4.60	0.26
RBC	10.35	10.08	9.75	8.80	10.85	8.73	10.31	10.30	9.92	0.38
Lymphocytes	89.50	87.66	89.50	83.25	84.50	82.66	86.66	86.66	86.66	2.04
Heterophils	9.50	11.83	10.25	15.75	14.50	16.66	12.83	13.20	13.50	1.91

PCV= packed cell volume. TP= total protein. Hb= haemoglobin. RBC= red blood cell

There were significant ($p<0.05$) differences in the total feed intake, daily feed intake final weight, daily weight gain, and no significant differences ($p>0.05$) for feed conversion ratio, age at first lay and first egg weight. The total feed intake and daily feed intake showed that birds in treatment group 3 (150cm²/bird + 100mg/kg vitamin C) consumed significantly higher than birds in treatment group 7 (90cm²/bird + 0mg/kg), 8 (90cm²/bird + 50mg/kg) and 9 (90cm²/bird + 100mg/kg). Total and daily feed intake for the other treatment groups were similar and did not differ significantly ($p<0.05$) with birds of treatment group 3, 7, 8 and 9. The final weight of quail birds in treatment group 1(150cm2/bird + 0mg/kg vitamin C) was the highest and treatment group 9 (90cm²/bird +100mg/kg vitamin) was found to be the lowest whereas all the other groups had similar values ($p<0.05$). Observations of stocking density on the haematological parameters of Japanese quail growers (2-6 weeks) are shown in Table 5. There were no significant($p<0.05$) differences for the blood parameters measured (packed cell volume, total protein, haemoglobin, red blood cell, lymphocyte, heterophil). This result shows that the stocking rate of 150cm²/bird, 120cm²/bird and 90cm² did not have a negative bearing on the haematological parameters of the birds for the duration of this experiment. This may be as a result of the homeostatic mechanism maintaining the constant internal environment in the body thereby keeping the normal physiological function of the birds as adduced by Rosales (1994). This result is also in cognizance with that of Tayeb *et al.* (2011) who reported insignificant differences among different density groups of broilers for packed cell volume, red blood cell, total protein, and differs only on haemoglobin which he reported to be significant among different density groups.9

Table 6 indicates the effect of vitamin C supplementation (0mg/kg, 50mg/kg, and 100mg/kg) on the haematological parameters of Japanese quail growers (2-6 weeks). There were no significant ($p<0.05$) differences for the blood parameters measured. This result implies that vitamin C supplementation at 0mg/kg, 50mg/kg and 100mg/kg did not cause any significant changes on the haematological parameters of the birds. Tuleun *et al.* (2011) reported that there was no significant difference between groups of quail birds supplemented with vitamin C and those without supplementation in red blood cell (RBC) count, haemoglobin (Hb) concentration, packed cell volume (PCV) and Total protein (TP).

Table 7 shows the interaction between stocking density and vitamin C supplementation on haematological parameters of Japanese quails (2-6 weeks). It indicates that there were no significant differences ($p<0.05$) for the blood parameters measured for the different stocking densities and vitamin C supplementation combinations at different levels.

CONCLUSION

Stocking density at 150cm2/bird resulted in a better total feed intake and final weight than 120cm2/bird and 90cm2/bird for growing phase whereas all other parameters where not affected by increase in density.

Supplementation with vitamin C at 0mg/kg, 50mg/kg and 100mg/kg did not result in significant improvement in the performance of the quails as far as the production parameters measured on the birds on different stocking density groups is concerned.

CONFLICT OF INTEREST

I certify that this is an original research work conducted by me and it has not been presented for publication elsewhere.

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