Effects of Sex and Stocking Density on Growth Performance and Some Physiological Traits of Japanese Quails (*Coturnix coturnix japonica*)

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Abstract

The performance and some physiological traits of male and female Japanese quails stocked at three different stocking densities were examined in a 21-day trial. A total of 216 three weeks old quail birds comprising 108 males and 108 females were used. Each sex was divided into three groups and randomly allotted to three stocking density groups of 40, 50 and 60 birds/m^2 achieved by altering floor spaces. Thus, making six treatment groups of 36 birds each with each group comprising of three replicates of 12 birds each. Data were collected on performance indices (feed intake, weight gain, feed conversion ratio and mortality), some physiological indices (respiration rate and rectal temperature) and litter moisture content. Stocking density had no significant ($P>0.05$) effect on the growth performance indices (feed intake, weight gain, feed conversion ratio and mortality) of the birds. Female quails had significantly higher ($P<0.05$) feed intake (3.33 vs 2.60 g/bird/day) and weight gain (69.93 vs 54.60 g/bird) with better feed conversion ratio (6.26 vs 7.79) than male quails. Significant ($P<0.05$) differences observed in weight gain and FCR as sex and stocking density interaction revealed that sex was majorly responsible as each sex shared similar ($P>0.05$) values regardless of the stocking density groupings with females showing the best weight gains (71.53, 70.30 and 67.97 g at 60, 50 and 40 birds/m^2 groups, respectively) and FCR (6.33, 6.24 and 6.24 at 60, 50 and 40 birds/m^2 stocking densities, respectively). Rectal temperature (range of 41.63 to 41.77 ^oC) and respiration rate (from 65.67 to 68.83 per min) did not differ significantly among the various stocking densities. Litter moisture (27.48, 30.52 and 31.13% across the group) increased numerically ($P>0.05$) with increased stocking density. Litter moisture was higher ($P<0.05$) in females (37.12%) than in males (22.30%). In conclusion, growing male and female quails can be stocked as high as 60 birds/m^2 without any resultant poor performance. Female quails are heavier with better feed conversion ratio than the males.

Keywords: Growth performance, physiological traits, stocking densities, Japanese quails.

Introduction

In Nigeria today, Japanese quail has caught attention of poultry farmers as there has been increased demand for its eggs which are often more expensive than chicken eggs. Japanese quail is a sexually dimorphic bird with females having a larger body size than males, unlike other poultry species. Shim (2005) stated that adult male weighs between 100 to 140 g while adult female is slightly heavier than the male, weighing from 120 to 160 g. Azeem and Azeem (2010) reported higher live body weight of female at 21, 28, 35, and 42 d of age compared with male quails. Souza *et al.* (1995) indicated that female birds were fatter than male because female hormone stimulated fat deposition. Kouichi *et al.* (2007) also found that female Japanese

quails exceeded the male in body weight and a significant sexual difference was observed after 40 d of age. In a related study by Du Preez and Sales (1997) on the growth rate of different sexes of the European quails (*Coturnix coturnix*), the mature body weight for males was 30 percent lower than that of females. Balcioglu *et al*. (2005) and Sezer and Tarhan (2005) reported differences in growth pattern between the sexes.

Quails are mostly reared in multi-tier cages both during growing and laying periods. The convenience of space and energy are major advantages with this system. However, quails are also being reared on the floor equally well (Padmakumar *et al.*, 2000). The ideal density at which to place broiler chickens during grow-out is an on-going debate with no definitive answer. It is natural to assume that birds will perform better when given more space. However, it's not more space but the improved environment that the added space may provide that is important. Birds can be placed at higher densities as long as the correct environment (temperature, ventilation, humidity) is provided (Brian, 2005; Yardimci and Kenar, 2008). Factors to consider when determining stocking density include bird size, feeder space, drinker space, house dimension, bird welfare, nutrition, breed, performance and economic returns. The ultimate goal is to maximize weight of chicken produced per square metre while preventing production losses due to overcrowding. In many cases, producers have to settle for slightly reduced performance to achieve a satisfactory economic return (Brian, 2005).

Seker *et al.* (2009) reported that increasing stocking density of Japanese quails resulted in linear reduction in feed intake. Camci and Erensanyin (2004) reported that stocking density did not affect feed conversion ratio in young quails as placement density (90, 60 and 45 birds /cm^2) was varied. However, Ahuja *et al.* (1992) reported that no significant difference on feed conversion ratio for quails stocked at 100 and 125 quails per cm^2. Also, it was reported by Al-Hall (2001) and Pettit-Riley and Estevez (2001) that higher stocking density resulted in significantly higher mortality during rearing period of quails. Litter moisture percentage also increased as stocking density increased in birds (Shivakumar *et al.*, 2004; Dozier *et al*., 2005; Dozier *et al*., 2006 and Jayalakshmi *et al.*, 2009).

A study by Feddes *et al.* (2002) demonstrated that when bird density was reduced live body and carcass weights were decreased. However, bird uniformity was higher at high densities. In that study, stocking density had no effect on mortality, breast meat yield, carcass grade, incidence of scratches, or carcass quality. It was concluded that high yield per unit area and good carcass quality could be achieved at the increased stocking density when adequate ventilation rates were provided. This study sought to investigate the effects of sex and stocking density on the performance, some physiological indices and litter moisture content in quails.

Materials and Methods

Site of Study

The study was carried out at the Directorate of University Farms (DUFARMS), Federal University of Agriculture, Abeokuta, Nigeria. The area lies on latitude $7^0$10'N and longitude $3^0$2'E and it is 76 m above sea level and located in the tropical rainforest vegetation zone.

Experimental Birds and Management

A total of 300 day-old quails were purchased from a reputable hatchery in

Ibadan, Nigeria. Chicks were brooded on deep litter for three wk using coal pot and hurricane lantern as source of heat. The floor of the pen was covered with newspaper in order to prevent birds from leg injuries. Stone pebbles were placed around the edges of the drinkers for the first wk in order to avoid chicks from getting wet and drowned in their drinker. Feed and water were provided *ad libitum*. Birds were fed diet containing 24.10% crude protein and 12.19 MJ/kg (Table 1). Liquid vitamins were given to the birds when necessary.

The birds were sexed and separated into male and female by observing for differences in the breast feather at the third week. A total of 216 birds comprising of 108 males and 108 females were randomly selected from the purchased sample of birds. Each sex was divided into three groups and randomly allotted to three stocking densities which included 40, 50 and 60 birds/m^2. Thus making six treatment groups of 36 birds each. Each group comprised of three replicates of 12 birds each.

Housing Structure and Dimension

The housing was a deep litter simple design constructed with wooden planks and wire nets while the roof was covered with iron sheet and the floor was cemented. The pen was partitioned into the various dimensions according to the stocking density. Each partition included an area of 0.04 m^2 each for feeder and waterer space. The various dimensions used to house 12 birds were 0.4m x 0.95m, 0.4m x 0.8m and 0.4m x 0.7m for 40, 50 and 60 birds/m^2 stocking densities, respectively.

Table 1: Gross composition of the experimental diet

Ingredients	0 – 6 wk
Maize	51.05
Soya bean cake	27.86
Groundnut cake	9.29
Fish meal	3.00
Wheat offal	5.00
Bone meal	2.50
Limestone	0.50
Lysine	0.10
Methionine	0.15
Common salt	0.30
Vitamin premix	0.25
Total	100.00
Calculated analysis	
Crude protein (%)	24.10
M. E. (MJ/kg)	12.19
Ether Extract (%)	4.0
Crude fibre (%)	3.80
Calcium (%)	1.2
Phosphorus (%)	0.60

Biomix® Vitaminm-mineral/premix containsVit. A - 4,000,000.00 IU; Vit D3 – 800,000.00IU; Vit. E – 9,200.00mg; Vit K – 800.00mg; thiamin (B_1) – 720.00mg; Riboflavin (B_2) – 2,000.00mg; Pyrodixine (B_2) – 1,200.00mg; Vit. B_{12} – 6.00mg; Biotin – 24.00mg; Niacin – 11,000.00gm; Panthothenicacid – 3,000.00gm; Folicacid – 300.00gm; Chlorinechloride – 120,000.00gm; Iron – 8,000.00gm; Manganese – 16,000.00gm; Copper – 1,200.00gm; Zinc – 12,000.00gm; Cobalt – 80.00mg; Iodine – 400.00gm; Selemium – 80.00gm; Antioxidants – 500.00mg * Determined values

Data Collection: Growth Performance Evaluation

Records of feed intake, weight gain and mortality were taken weekly. Feed conversion ratio (FCR) was also be obtained by calculation.

Weight gain (g): The birds were weighed per replicate basis at the start of the experiment and subsequently on a weekly basis. Weight gain = Final weight – Initial weight

Feed intake (g): A known quantity of feed was given to birds while the leftover of feed was weighed to determine daily feed intake and consequently weekly feed intake. The feed intake was calculated as: Feed conversion ratio (FCR) determined by calculating the ratio of feed intake to weight gain.

Physiological Indices

The respiration rate and rectal temperature were determined fortnightly by randomly selecting three birds per replicate during the study. The rectal temperature was measured with a digital thermometer (0.1 ^{o}C accuracy), which was inserted into the rectum of the bird for 1 min as described by Yahav and McMurtry (2001). The respiratory rate (RR) of the birds was taken as the number of breaths per min.

Litter Moisture Content

Litter samples were taken randomly from each replicate fortnightly. The samples were labelled, weighed, oven dried at 100 ^{o}C overnight and reweighed to determine the litter moisture percentage (AOAC, 2000).

Statistical Analysis

Data collected were subjected to one-way Analysis of Variance in a 3 x 2 Factorial experimental layout using SPSS 2007 version 16 for Windows. Significant ($P<0.05$) differences among treatment means were separated using Duncan Multiple Range Test of the software.

Results and Discussion

The stocking density did not significantly ($P>0.05$) affect any of the performance indices considered (Table 2). However, sex of the birds influenced ($P<0.05$) the weight gain with female birds having a higher (69.9 vs. 54.6g) body weight gain than their male counterparts. Feed intake was similar in both sexes, however, males showed poorer feed conversion ratio (7.79 vs. 6.28) compared to females. Body weight of female birds increased at an increasing rate which eventually overtook the male body weight at the fifth week and left a wide gap at the end of the sixth week (Figure 1).

Weight gain for the 3-wk study was similar ($P>0.05$) among stocking densities and varied significantly ($P<0.05$) within sexes (Table 3). Females recorded weight gain of 71.53, 70.30 and 67.97 g at stocking densities of 40, 50 and 60 birds/m^2, respectively, as against lower ($P<0.05$) values (54.17, 53.33 and 56.30g, respectively for same stocking densities) recorded in males. Feed intake was similar ($P>0.05$) across the treatment groups. Females showed better feed conversion ratio regardless of the stocking density.

Table 2: Main effect of stocking density and sex on growth performance of Japanese quails

	Stocking density (birds/m^2)				Sex		
Parameters	40	50	60	SEM	Male	Female	SEM
Total weight gain (g)	62.14	61.82	62.85	2.56	54.60^{b}	69.93^{a}	2.09
Daily weight gain (g/day)	2.96	2.94	2.99	0.12	2.60^{b}	3.33^{a}	0.10
Total feed intake/bird (g)	426.98	428.79	434.49	6.95	423.34	436.82	5.68
Daily Feed intake (g/day)	20.33	20.42	20.69	0.33	20.16	20.80	0.27
Feed Conversion Ratio	6.95	7.10	7.05	0.22	7.79^{a}	6.28^{b}	0.18
Mortality (%)	1.39	0.00	0.00	0.80	0.93	0.00	0.65

^{ab}Means with different superscripts in the same row differ significantly ($P<0.05$)

Table 3: Effect of interaction between stocking density and sex on growth performance of Japanese quails

Parameters	Stocking density (birds/m^2)						
	40		50		60		
	Male	Female	Male	Female	Male	Female	SEM
Total weight gain (g)	56.30[b]	67.97[a]	53.33[b]	70.30[a]	54.17[b]	71.53[a]	3.61
Daily weight gain (g/day)	2.68[b]	3.24[a]	2.54[b]	3.34[a]	2.58[b]	3.41[a]	0.17
Total feed intake (g)	430.70	432.25	420.77	436.80	418.57	450.41	9.83
Daily Feed intake (g/day)	20.05	20.16	20.04	20.80	19.93	21.45	0.47
Feed Conversion Ratio	7.66[a]	6.24[b]	7.94[a]	6.24[b]	7.76[a]	6.33[b]	0.32
Mortality (%)	2.78	0.00	0.00	0.00	0.00	0.00	1.13

[ab]Means with different superscripts on the same row differ significantly (P<0.05)

Rectal temperature and respiration rate were not different (P>0.05) among the stocking densities (Table 4). Rectal temperature ranged from 41.63 to 41.77 ^{0}C and respiration rate range was from 65.67 to 68.83 per min among the stocking densities. Rectal temperature and respiration rate were similar (P>0.05) in both sexes. Litter moisture was not significantly (P>0.05) different across the stocking densities. Litter moisture content in females (37.12%) was higher (P<0.05) than in males (22.30%).

Stocking density and sex interaction did not affect (P>0.05) the rectal temperature and respiration rate across the treatment groups (Table 5). Litter moisture content differed significantly (P<0.05) across the groups with males showing the least values irrespective of the stocking density. However, it was observed that moisture values in females were higher (P<0.05) than their male counterpart and decreased with decreasing stocking density.

Generally, quail performance was similar for all the stocking densities. This could be a result of constant feeder space sufficient to allow easy access to feed. Also the design of the pen which gave room for adequate ventilation might have reduced the possible effect of overcrowding in highly stocked groups to the bearest minimum.

Table 4: Main effects of stocking density and sex on some physiological traits and litter moisture content of Japanese quails

Parameters	Stocking density (birds/m^2)				Sex		
	40	50	60	SEM	Male	Female	SEM
Rectal temperature (^{o}C)	41.70	41.77	41.63	0.07	41.77	41.63	0.06
Respiration rate (per min)	66.50	68.83	65.67	1.72	66.89	67.11	1.41
Litter moisture (%)	27.48	30.52	31.13	1.73	22.30[b]	37.12[a]	1.41

[ab]Means with different superscripts on the same row differ significantly (P<0.05)

Table 5: Interaction effects between stocking density and sex on some physiological traits and litter moisture condition of Japanese quails

Parameters	Stocking density (birds/m^2)						
	40		50		60		
	Male	Female	Male	Female	Male	Female	SEM
Rectal temperature (^{o}C)	41.80	41.60	41.77	41.77	41.73	41.53	0.10
Respiration rate (per min)	68.00	65.00	68.33	69.33	64.33	67.00	2.44
Litter moisture (%)	22.67^c	32.29^b	22.78^c	36.26^{ab}	21.44^c	40.81^a	2.44

^{ab}Means with different superscripts on the same row differ significantly (P<0.05)

Weight gain among the quail groups was similar and this agrees with the earlier reports by Ahuja *et al*. (1992) and Turkyilmaz (2008) that stocking density had no significant effect on live body weight. In contrast, Nagarajan *et al*. (1991) indicated that final body weights at 26th week of age were significantly influenced by the cage space in quails – a variation which could be attributed to the age of the birds. Feddes *et al*. (2002) and Makowski *et al*. (2004) reported that stocking density significantly affected body weight of broiler chicken which could be as a result of the body size difference bewteen broiler chicken and quails.

Similar feed intake obtained among the stocking density groups in this study disagreed with decreased feed intake as space per bird decreased in broiler chicken reported by some authors (Feddes *et al*., 2002; Al-Homidan and Robertson, 2007). Seker *et al*. (2009) also reported that increasing stocking density of Japanese quails resulted in linear reduction in feed intake. Variation in this result with that of Seker *et al*. (2009) could be due to constant feeding space and water space across the stocking densities adopted in this study.

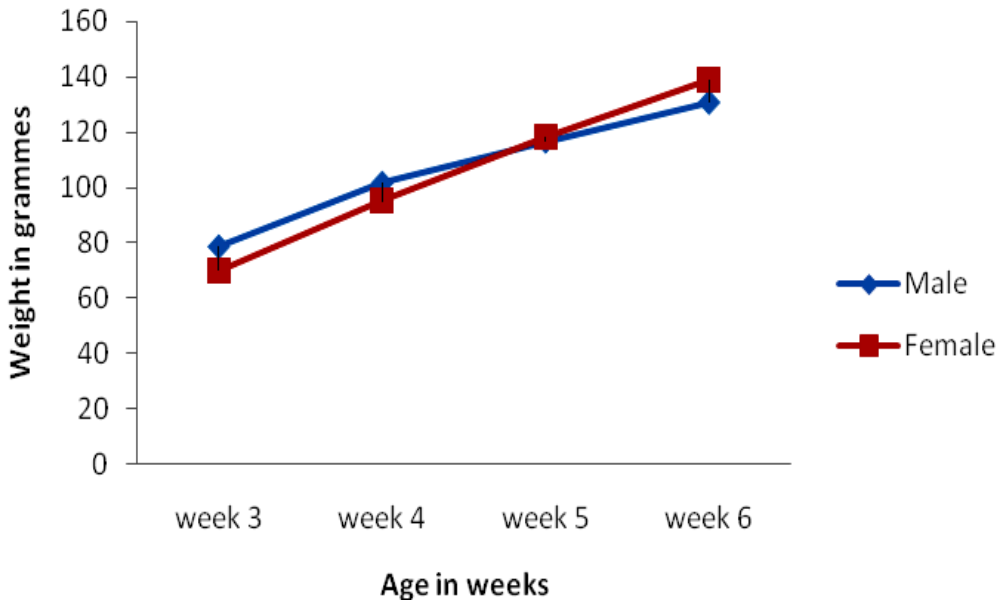

Figure 1: Weekly weight of male and female quails

In this study, FCR was not affected by stocking density and this result is corroborated by Camci and Erensanyin (2004) who reported that stocking density did not affect FCR in young quails as placement density (45, 60 and 90 cm^2) was varied. Also Tozluca (1993), Sengul and Tas (1997) and Nagarajan *et al.* (1999) reported no significant effect of stocking density on FCR in quails.

Tinoco *et al.* (2007) and Turkyilmaz (2008) reported that stocking density did not affect mortality – a similar result on mortality as obtained in this study. However, in contrary Al-Hall (2001) and Pettit-Riley and Estevez (2001) reported that higher stocking density resulted in significantly higher mortality during rearing period of quails.

Weight gain and FCR in female quails were better than in male quails in this study. Better weight gain in females could be as a result of heavier gonads than that of males. Japanese quail is a sexually dimorphic bird with females having a larger body size than males, unlike other poultry species. In a related study by Du Preez and Sales (1997) on the growth rate of different sexes of the European quails (*Coturnix coturnix*), the mature body weight for males were 30 percent lower than for females. Balcioglu *et al*. (2005) and Sezer and Tarhan (2005) reported differences in growth pattern between the sexes.

Higher initial weight at third week of growth of males could be due to earlier maturity in males than in females which means they needed to attain a significant body mass for onset of maturity. Du Preez and Sales (1997) stated that females reached the point of maximum growth 4.7 d later than males. Similar results were reported by Mills *et al.* (1997) and Boon *et al.* (2000).

Rectal temperature and respiration rate were not in any way influenced by either stocking density or sex and this could be due to the adequate ventilation across the pen. According to Yardimci and Kenar (2008), the magnitude of the effect of density depends on technical factors such as quality of ventilation and cooling systems as well as management factors, for examples litter condition and light programmes. This result agrees with those obtained by Abdel- Hakim *et al.* (2005) and Askar *et al.* (2012) who indicated that stocking density had no effect on rectal temperature of Japanese quails. However, Abdel-Azeem (2010) reported lower rectal temperature, heart rate and respiration rate for quails kept at 77 birds/m^2 as compared with those kept at 143 birds/m^2 or birds kept at 100 birds/m^2. Higher stocking densities managed in cages used by Abdel-Azeem (2010) could be responsible for the difference in the results reported and those obtained in this study in which the birds were managed in cages.

Litter moisture increased linearly with increased stocking density because litter quantity reduces as the space decreases; hence fewer litter materials were available to absorb moisture from the birds' droppings. Also better air movement at the birds' level within the lowly stocked groups could be responsible for the lower litter moisture content. Several authors (Shivakumar *et al.*, 2004; Dozier *et al*., 2005, Dozier *et al*., 2006 and Jayalakshmi *et al.*, 2009) reported increased moisture content as stocking density increased in birds. This study revealed that litter moisture was higher in female quails than in males.

Conclusion

This study revealed that stocking birds at 40-60 birds/m^2 gave similar performance in male and female quails. Female quails have higher live weight than males at maturity. Physiological traits in male and female quails were similar. Litter moisture increased with increasing stocking density.

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