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Carcass Characteristics of Japanese Quails (*Coturnix coturnix japonica*) Managed Under Varying Stocking Densities During Seasonal Transition

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Abstract

The aim of this study was to assess the carcass characteristics of Japanese quails (Coturnix coturnix japonica) managed under varying stocking densities during the transition from dry to rainy period. A total of two hundred and ninety-six day-old and apparently healthy Japanese quails were used for the study for a period of eight weeks. They were divided into four stocking densities of 252.20cm^2/bird (11birds); 173.43 cm^2/bird (16birds), 132.10 cm^2/bird (21birds), and 106.73 cm^2/bird (26birds) that represented Treatments 1-4 respectively. The treatments were replicated four times in a completely randomized design. Data collected were analyzed using linear model procedure for one-way analysis of variance. The results showed that females recorded significantly (P<0.05) higher values for all the organs measured- liver, heart, gizzard and proventriculus than male quails. Stocking density in this study had no significant effect (P ≥0.05) on body length, shank length, thigh length, wing length and shank circumference but were all better at lower stocking densities. The percentage edible meat of quail in this study is higher than in most poultry species thereby suggesting its higher efficiency in terms of meat production. Finally, stocking densities of 173.43cm^2/bird and 132.10cm^2/bird could therefore be considered for quail production during high environmental temperature without compromising quail welfare.

Keywords: *Carcass, Stocking Densities, Japanese Quails, Seasonal Transition*

INTRODUCTION

The Japanese quail **(***Coturnix coturnix japonica***)** is conventional source of animal protein of high biological value for human consumption. They are kept for both commercial and scientific purposes. The meat and egg from quails are noted for high their high nutritional and medicinal values (Mushava, 2016; Genvchev, 2012). These products are particularly significant because they are low in cholesterol (Jeke *et al*.,2018). Quails are good and economical source of animal protein because of their fast growth potential, early maturity, high rate of egg production, short generation interval and small body size that allows large number of birds to be kept in a small space. The percentage edible meat in Japanese quails is higher than in most other poultry species; indicating its high efficiency for meat production. Narayan, (2006) reported that quails slaughtered at 5 - 6

weeks had dressing percentage of 60 - 80% with an average of 75% which is much higher than in broiler chickens of the same age.

Apparently, quails are susceptible to changes in environmental temperature and thus cannot effectively dissipate the heat produced. Heat stress has been reported to affect various physiological parameters of birds. It increases rectal temperature (Salvador *et al.,* 1999; Aro *et al.,* 2017) and increases the respiration rate (Inoue *et al.*, 1995). High environmental temperature compromises performances and productivity in poultry through reduced feed intake, decreased nutrient utilization, growth rate, egg production, egg quality and feed efficiency which lead to economic losses in poultry. The influence of stocking density of different poultry species on growth and reproductive performance has generated considerable interest in recent years. However, there is little information on the influence of stocking density on Japanese quails. High stocking density has been shown to induce poor leg condition, reduction in growth rate and a high incidence of dermatitis attributable to deteriorating litter condition (Elwinger, 1995). In a high stocking density condition, airflow at the ambient environment of birds is often reduced resulting in reduced dissipation of body heat to the air, poor air quality due to inadequate air exchange, increased ammonia due to accumulation of litter and reduced access to feed and water. Puron *et al.,* (1995) showed that reducing floor space of broiler chickens can reduce growth rate, feed efficiency, livability, and in some cases, carcass quality. Fahmy *et al.,* (2005) indicated that increasing stocking density of quail was associated with marked significant decrease in weight and significant reduction in blood AST (Aspartate Aminotransferase) and significant increase in total lipid. Seker *et al.,* (2009) showed that increasing stocking density of Japanese quails from 10 to 20 birds per m^2 resulted in a linear reduction in body weight and feed intake. Stocking density and group size are significantly environmental factors that affect the amount and quality of production in cage breeding of quails. However, mortality rate increased with increasing group size. Studies that investigate the combined effect of group size or stocking density and high environmental temperature on growth performance, carcass characteristics and other traits of Japanese quail are limited in number. This study was aimed at investigating the carcass characteristics of Japanese quails (*Coturnix coturnix japonica*) managed under varying stocking densities during the transition from dry to rainy period.

METHODOLOGY

Experimental site

The study was conducted between February to April 2019 during the transition from dry to rainy season at the Poultry Unit of the Teaching and Research Farm, Federal University of Technology, Akure, Ondo State, Nigeria. Akure lies on latitude 7.25^0 N and longitude 5.19^0 E in south -western, Nigeria. Its location is at 396 meters high above sea level and being characterized by high temperatures and high humidity. It has two seasons – wet season and dry season. The wet season lasts for about 7months (April to October) with an annual rainfall of about 1524mm. The dry season lasts for about 5months from October 28 to April 7.

Management of the birds

A total of 296 day-old sexed and apparently healthy Japanese quails were used for the study for a period of 8 weeks. They were divided into four stocking densities of 252.20cm^2/bird (11birds); 173.43 cm^2/bird (16 birds), 132.10 cm^2/bird (21birds), and 106.73 cm^2/bird (26 birds) that represented Treatments 1-4 respectively. The treatments were replicated four times adopting a

completely randomized design (CRD). Both sexes were housed together in a battery cage system and fed without restriction. Six quails per replicate were sampled and tagged for the measurement of carcass quality.

Data were taken on daily feed intake (FI) as the difference in weight between the feed given and the left-over feed per day, these were summed up to obtain the feed intake per week in gram(g) for a five-week growth study. Initial weight (g) and final weight (g) were also measured. These were done to determine the rate of growth per week and feed conversion ratio (FCR).

Weight Gain (WG) = Final weight - Initial weight (1)

Feed Conversion Ratio (FCR) = Feed intake(g)/Weight gain(g) (2)

Carcass analysis

Four (2 male and 2 female) quails per replicate were slaughtered at the end of the study. The slaughtering followed the Guidelines for the Care and of Use of laboratory Animals (National Research Council NRC, 2011). Their organs were cut out, weighed and their relative body weights were determined as the weight of the organ divided by the live weight of the bird. The following parameters were considered, Live weight, dressed weight, weight of the head, neck, chest, back, left and right thigh, left and right drumstick and left and right shanks. The following organs were eventually dissected and weighed: the liver, heart, gizzard and proventriculus and their relative body weights were determined. All measurements of weight were taken using a digital weighing scale. The relative body weight was determined mathematically in equation (3) as:

$$\text{Relative Body Weight (RBW)} = \frac{\text{Weight of the organ}}{\text{Live weight}} \times 100 \quad (3)$$

Statistical analysis

All the data generated were analyzed using linear procedure for one-way analysis of variance (ANOVA) in a completely randomized design (CRD) with the Statistical Package of Social Sciences (SPSS) Version 24.0 of 2016. Means with difference were separated using Duncan's Multiple Range Test of the same statistical package at 0.05 % level of significance.

RESULTS AND DISCUSSION

Japanese Quail performance under different stoking densities

The performance of Japanese Quails on the four stocking densities is shown in Table1. Average final weight gain/bird(g) and Average weight gain/bird(g) did not differ ($P>0.05$) between birds kept at the four stocking densities (T1-T4). Feed conversion ratio (FCR) was low at low stocking density. Inversely, feed efficiency (FE) showed decrease with increasing stocking density. This result is in accord with the findings of Erensayin (2001) that feed conversion ratio was better in quails kept on an increased group size. Conversely, Davidson and Leighton (1984) indicated that high population density caused lower feed efficiency than did a relatively low population density. Percentage mortality was significantly ($P<0.05$) different across the four stocking densities. The mortality was highest at 106.73cm^2/bird(26birds) and nil for birds at stocking densities of 132.10 cm^2/bird (21birds). The highest mortality rate for T4 is explained by the birds' struggle for space which limited their capacities for survival.

Table 1: Performance parameters of growing Japanese quails reared under different stocking densities (February to April).

Parameters	T1	T2	T3	T4
Ave. Initial Weight/bird (g)	66.48±1.78	64.44±1.59	67.57±1.27	69.31±2.42
Ave. Final Weight/bird (g)	144.79±6.33	136.73±1.24	137.28±1.36	135.48±1.86
Ave. Weight Gain/bird (g)	78.31±7.75	72.29±2.09	69.70±1.44	66.17±2.52
Ave. Feed Intake/bird (g)	556.85±9.14^{b}	507.40±1.38	558.78±2.07^{b}	597.39±1.05^{a}
Ave. water intake/bird (ml)	78.77±1.85^{a}	69.53±1.15^{b}	68.49±1.25^{b}	66.55±1.11^{b}
Feed conversion ratio	7.12±0.63^{b}	7.02±0.20^{b}	8.02±0.20^{ab}	9.03±0.34^{a}
Feed Efficiency	0.14±0.01^{a}	0.14±0.00^{a}	0.12±0.00^{ab}	0.11±0.00^{b}
Mortality	0.25±0.25^{b}	0.25±0.05^{b}	0.00±0.00^{c}	1.75±1.05^{a}
Mortality Percentage	2.22±0.57^{b}	1.56±0.89^{c}	0.00±0.00^{d}	8.33±1.68^{a}

a, b, c, d = Means on the same rows but with different superscripts are statistically ($P<0.05$) significant.

T1 = 252.20cm^2/bird (11 birds), T2 = 173.43cm^2/bird (16 birds), T3 = 132.10cm^2/bird (21 birds) and T4 = 106.73cm^2/bird (26 birds).

Carcass parameters of male Japanese Quail

The results of carcass parameters of male Japanese quails reared under different stocking densities during the transition from dry to rainy season are presented in Table 2. The results showed that there were no significant differences in live weight, weight of head, neck, right and left drumstick, right and left shank and weight of back in male Japanese quail. Significant differences were observed in dressed weight which was lowest in T1 but highest in T2 through T4. The dressed weight obtained is relative to the live weight of the Japanese quail. Although, Abdel-Azeem (2010) reported high dressed weight in birds stocked in lower stocking density, Seker *et al.* (2009) and El-Shafei (2012) observed insignificance differences on slaughter and carcass characteristics of Quails. Higher values were obtained in weights of neck, right and left thigh, chest and back in quails stocked at the lowest density. Low stocking density reduced competition for feed and water and bird have more nutrients to convert to body mass. Relative carcass parameters of male quail expressed as a percentage of live weight in Table 3 indicates that relative weight of right thigh and chest were significantly high when the cage density was low while it was the reverse for relative weight of back. Other relative carcass parameters measured were not different ($P \geq 0.05$) statistically. Raji *et al.*, (2015) reported that higher percentage of edible meat in Japanese quails,

compared to most poultry species; indicating its high efficiency for meat production. Quails slaughtered at 5 - 6 weeks had dressing percentage of 60 - 80% with an average of 75% which is much higher than in broiler chickens of the same age Narayan *et al.* (2006). This result was in agreement with Thomas *et al.* (2004) who indicated that stocking density had no influence on the carcass characteristics. Whereas, Feddes *et al.* (2002) observed that birds grown at highest stocking density had lower carcass weight.

Table 2: Carcass parameters of male Japanese quails reared under different stocking densities

Parameters (g)	T1	T2	T3	T4
Live weight	148.38±1.23	153.43±7.79	159.35±2.33	152.13±1.09
Dressed weight	83.78±2.58^{b}	91.13±2.64^{a}	91.03±6.32^{a}	89.38±1.00^{a}
Weight of head	7.00±0.24	6.30±0.38	7.08±0.30	7.03±0.24
Weight of neck	6.83±1.03	5.38±0.57	6.65±0.73	6.30±0.69
Weight of left thigh	7.70±0.51^{a}	7.00±0.41^{b}	6.13±0.40^{c}	6.48±0.59^{c}
Weight of right thigh	8.25±0.41^{a}	7.00±0.00^{ab}	7.38±0.51^{ab}	6.53±0.41^{b}
Weight of left drumstick	5.80±0.32	4.75±0.25	5.45±0.66	5.05±0.39
Weight of right drumstick	5.83±0.28	5.50±0.50	5.60±0.53	5.53±0.30
Weight of left shank	1.60±0.24	1.25±0.25	1.78±0.08	1.42±0.08
Weight of right shank	1.63±0.24	1.25±0.25	1.58±0.14	1.78±0.15
Weight of chest	35.60±1.55^{a}	26.23±1.55^{c}	32.78±1.60^{ab}	29.80±2.08^{bc}
Weight of back	27.18±1.84	25.88±1.16	28.70±1.98	29.83±2.76

a, ab, b, bc, c, = Means on the same rows but with different superscripts are statistically ($P<0.05$) significant.

Table 3: Relative carcass parameters of male Japanese quails reared under different stocking densities

Parameters (%)	T1	T2	T3	T4
Relative weight of head	4.72±0.20	4.11±0.24	4.47±0.27	4.62±0.18
Relative weight of neck	4.61±0.71	3.51±0.38	4.27±0.71	4.15±0.48
Relative weight of left thigh	5.19±0.35	4.58±0.32	5.14±0.38	4.27±0.42
Relative weight of right thigh	5.56±0.26^{a}	4.57±0.07^{b}	4.67±0.41^{ab}	4.30±0.31^{b}
Relative weight of left drumstick	3.68±0.24	3.10±0.17	3.65±0.37	3.32±0.64
Relative weight of right drumstick	3.93±0.19	3.57±0.27	3.54±0.35	3.64±0.22
Relative weight of left shank	1.08±0.16	0.82±0.17	1.13±0.10	0.94±0.46
Relative weight of right shank	1.10±0.17	0.82±0.17	0.99±0.07	1.17±0.11
Relative weight of chest	24.01±1.16^{a}	17.12±1.14^{b}	20.82±1.88^{ab}	9.60±1.41^{ab}
Relative weight of back	18.34±1.38^{b}	16.90±0.95^{c}	19.10±1.30^{a}	19.64±1.92^{a}

a, ab, b, c = Means on the same rows but with different superscripts are statistically ($P<0.05$) significant.

Carcass parameters of female Japanese quails

The results of carcass parameters of female Japanese quails reared under different stocking densities during the transition from dry to rainy season in Table 4 indicates significant differences ($P < 0.05$) for the live weight, dressed weight, drumstick and weight of back. Dressed weight for female Japanese quail was highest in the highest stocking density as observed in the male quail. This is relative to the higher live weights observed in the higher stocking density while the value of the weight of drumstick and back were higher at the lower stocking densities. The relative weights of drumstick and back in Table 7 were highest in female quails with the lowest cage density proportionately with their weight obtained in Table 4. The higher weight values obtained in lower stocking densities may be attributed to increase space for feeding and reduced stress which increased the relative muscle weight. The high stocking density of growing quail can lead to heat accumulation in cage, thereby increasing the risk of heat stress and reduced metabolism. Quails in low stocking regime therefore metabolized feeds better for conversion to body muscle. In male broiler chickens, stocking density of over 30 kg/m^2 was associated with decreased growth rate, and lower carcass weight and meat yield Dozier *et al.*, (2006). Cravener *et al.*, (1992) showed that stocking density at 0.05m^2/bird decreased significantly carcass weight compared to those stocked at 0.07, 0.09 and 0.11m^2/bird. Beg *et al.*, (2011) opined that the dressing percentage was significantly higher when broiler was stocked at 8 and 10 birds/m^2 compared with those stocked at 12 or 14 birds/m^2.

Table 4: Carcass parameters of female Japanese quails reared under different stocking densities

Parameters (g)	T1	T2	T3	T4
Live weight	148.55±1.91^{c}	159.50±3.09^{b}	169.45±0.77^{a}	165.90±1.61^{a}
Dressed weight	77.55±1.97^{c}	86.95±2.73^{b}	98.30±2.18^{a}	94.53±1.19^{a}
Weight of head	6.20±0.37	6.53±0.60	6.50±0.50	6.75±0.25
Weight of neck	5.65±0.64	5.33±0.20	6.75±0.75	5.50±0.29
Weight of left thigh	7.13±0.45	8.03±0.44	7.75±0.48	7.25±0.63
Weight of right thigh	7.48±0.41	7.82±0.28	7.50±0.29	7.25±0.75
Weight of left drumstick	5.78±0.50^{a}	4.95±0.05^{ab}	5.25±0.25^{ab}	4.75±0.25^{b}
Weight of right drumstick	5.40±0.22	5.13±0.43	5.25±0.25	5.00±0.41
Weight of left shank	1.50±0.10	1.60±0.23	1.00±0.00	1.50±0.29
Weight of right shank)	1.60±0.22	1.20±0.20	1.50±0.29	1.75±0.25
Weight of chest	34.08±2.27	38.00±1.24	36.25±1.60	38.00±0.71
Weight of back	22.80±1.26^{a}	18.38±0.94^{b}	17.00±0.91^{bc}	15.25±0.48^{c}

a, ab, b, bc, c, = Means on the same rows but with different superscripts are statistically ($P<0.05$) significant.

Table 5: Relative carcass parameters of female Japanese quails reared under different stocking densities

Parameters (%)	T1	T2	T3	T4
Relative weight of head	4.17±0.21	4.10±0.40	3.83±0.29	4.07±0.16
Relative weight of neck	3.80±0.41	3.47±0.11	4.21±0.35	3.62±0.16
Relative weight of left thigh	4.80±0.30	5.22±0.25	4.91±0.44	4.76±0.38
Relative weight of right thigh	5.04±0.32	5.10±0.15	4.76±0.40	4.77±0.50
Relative weight of left drumstick	3.89±0.33^{a}	3.23±0.04^{ab}	3.31±0.20^{ab}	3.12±0.17^{b}

Relative weight of right drumstick	3.64±0.13	3.33±0.25	3.31±0.20	3.29±0.28
Relative weight of left shank	1.01±0.07	1.05±0.61	0.63±0.03	0.99±0.19
Relative weight of right shank	1.08±0.14	0.79±0.14	0.93±0.16	1.15±0.17
Relative weight of chest	22.99±1.66	24.78±0.80	22.90±1.39	24.97±0.36
Relative weight of back	15.36±0.82^{a}	12.00±0.76^{b}	10.73±0.65^{b}	10.03±0.33^{b}

a, ab, b, = Means on the same rows but with different superscripts are statistically ($P<0.05$) significant.

T1 = 252.20cm^2/bird (11 birds), T2 = 173.43cm^2/bird (16 birds), T3 = 132.10cm^2/bird (21 birds) and T4 = 106.73cm^2/bird (26 birds).

Organ parameters of male and female Japanese Quails

The data obtained for organ parameters of male and female Japanese quails in Table 6 indicated that there were significant differences ($P<0.05$) in all the organs measured. However, the significant difference does not follow a well -defined order. The liver in male and female were all highest at T1 stocking density and lowest in T2. Concerning sex, the results revealed that females recorded significantly ($P<0.05$) higher values for all the organ measured- liver heart, gizzard and proventriculus than male quails except in liver where male quail presents higher weight of liver than the female quails. This result disagreed with Tollba *et al.*, (2006) that showed that increasing stocking density did not significantly impact on the giblets as was observed in laying hens.

Table 6: Organ parameters of male and female Japanese Quails reared under different stocking densities

Parameters (g)	**T1**	**T2**	**T3**	**T4**
Liver (male)	2.60±0.04^{a}	1.22±0.95^{b}	1.85±1.14^{b}	1.73±1.25^{b}
Heart (male)	1.15±0.96^{c}	1.20±0.04^{b}	1.48±0.15^{a}	1.23±0.06^{b}
Gizzard (male)	2.00±0.42^{b}	2.25±0.19^{b}	2.43±0.80^{b}	2.90±0.15^{a}
Proventriculus (male)	0.58±0.09	0.50±0.04	0.60±0.09	0.43±0.03
Liver (female)	1.67±0.34^{a}	1.08±0.35^{d}	1.25±0.48^{c}	1.50±1.26^{b}
Heart (female)	1.25±0.18^{a}	1.10±0.04^{a}	1.00±0.00^{b}	1.00±0.00^{b}
Gizzard (female)	2.93±0.39^{b}	3.22±0.19^{a}	3.00±0.41^{b}	2.75±0.25^{b}
Proventriculus (female)	0.80±0.04	0.88±0.08	1.00±0.0	0.83±0.11

a, b, c, d = Means on the same rows but with different superscripts are statistically ($P<0.05$) significant.

CONCLUSION

Body weight and yield are important traits extolled by poultry breeders and processors to achieve high profitability in the venture. The percentage edible meat is thus higher than in most poultry species which suggest its high efficiency for meat production. Stocking density in Japanese quails should however, not exceed 132.10 cm^2/bird for optimum growth and productive performance.

References

Abdel-Azeem, F. Abdel-Azeem (2010). The Influence of Different Stocking Density and Sex on Productive Performance and Some Physiological Traits of Japanese quail. *Egypt. Poult. Sci.* 30 (I),203-227.

Aro, S. O., Osho, I. B. and Awoneye, O. O. (2017). Comparison of rectal and ambient temperatures of Isa Brown and Harco Black layers fed different level of acetyl salicylic acid. *Animal Research International.* 14(1),2691-2696.

Beg, M. A. H., Baqui, M. A., Sarker, N. R. and Hossain, M. M. (2011). Effect of stocking density and feeding regime on performance of broiler chicken in summer season. *Int. Journal of Poult. Sci.* 10 (5),365-375.

Cravener, T. L., Roush, B. W. and Mashaly, M. M. (1992). Broiler production under varying population densities. *Poult. Sci.,* 71,427-433.

Davidson, J. G. and Leighton, A. T. (1984). Effects of light environment and population density on growth performance of male Turkeys. *Poultry Science,* 63,1314-1321.

El- Shafei, A. A., Abdel – Azeem, A. F. and Abdullaha, E. A. (2012). Stocking density effects on performance and physiological changes of laying Japanese quail. *J. Animal and Poultry Prod. Mansoura Univ.*,3 (8), 379 - 398

El-winger, K. (1995). Broiler production under varying population densities – a field study. *Archiv fur Geflugelkunde,* 59,209-215.

Erensayin, C. (2001). Effects of the group size on fattening performance in quails. *Journal Institute of Natural and Applied Science,* 5(3),85-89.

Fahmy, M. O., El-Faramawy, A. A. and Gabr, S. A. (2005). Changes in Blood parameters, reproductive and digestive systems of Japanese quail as response to increase population density. *Isotope and Rad. Res.,* 37(2),287-298.

Feddes, J. J., Emmanuel, E. J. and Zuidhoft, M. J. (2002). Broiler performance, body weight variance, feed and water intake, and carcass quality at different stocking densities. *Poultry Science,* 81,774-779.

Genvchev, A. (2012). Quality and composition of quail eggs (Coturnix japonica) *Trakia J. Sci.*,10(2),91-101

Inoue, Y., Zhou, W. and Yamamoto, S. (1995). Effects of short time heat exposure on thermoregulating physiological responses and heat acclimation in broilers. *Japanese Poultry Sci.,* 32,289–95.

Jeke, A., Phiri, C., Chitilingu,K and Taru, P. (2018). Ethnomedicinal use and pharmacological potential of Japanese quail (Coturnix cturnix japonica) birds' meat and eggs, and its

potential implications on wild quail conservation in Zimbabwe: A review. *Cogent Food and Agriculture* 4(1) https://doi.org/10.1080/23311932.2018.1507305

Mushava, S. (2016). *Another day, another quirk? The Herald. Zimbabwe. 30 April*

Narayan, R., D. P. (2006). Japanese Quail Breeding: Present Status and Future Strategies. In P.V.K. Sasidhar (Ed.). *Central Avian Research Institute, Izatnagar-243 122 (India).*

National Research Council NRC (2011). *Guide for the care and use of laboratory Animals (8th ed)* Washington D. C: The National Academies Press

Puron, D. Santamaria, R. Segaura, J. C. and Alamilla, J. L. (1995) Broiler performance at different stocking densities. *Applied Poultry Research*. 4,55-60.

Raji, A. O., Girgiri, A. Y., Alade, N. K. and Jauro, S. A. (2015). Characteristics and proximate composition of Japanese Quail (*Coturnix coturnix Japonica*) Carcass in A semi-arid area of Nigeria. T*rakia Journal of Sciences*. 2,159-165.

Salvador, D., Ariki, J., Borges, S. A., Pedroso, A. A. and Moraes, V. M. B. (1999). Sodium bicarbonate supplementation in ration and drinking water of heat stressed broilers. *Ars-Veterinaria*, 15,144–148.

Seker, I., Selim, K. and Metin, B. A. (2009). Effect of group size on fattening performance, mortality rate, slaughter and carcass characteristics in Japanese quail (*Coturnix coturnix japonica*). *Journal of Animal and Veterinary Advances* 8(4),688-693.

Thomas D., Ravindran V., Thomas D.V., Camden B. J., Cottam Y. H., Morel P. C. H. and Cook C. J. (2004). Influence of stocking density on the performance, carcass characteristics and selected welfare indicators of broiler chicken. *New Zealand Vet J*. 52, 76-81.

Tollba, A. A., Rizkalla, H. E. and Abd El-Samad, M. H. (2006). Effects of stocking density on productive and physiological performance of Egyptian laying chickens. *Egypt. Poult. Sci.* 26 (I),347-366.