JOURNAL OF
SUSTAINABLE AGRICULTURE
AND THE ENVIRONMENT

E-mail: jsae@mouau.edu.ng. Website: www.mouau.edu.ng.

Influence of Weight Group on Growth Performance of Sigmond Strain of Japanese Quail (*Coturnix coturnix japonica*) in a humid rain-forest zone of Nigeria.

***O. M. Obike and N. J. Iwuji**

Department of Animal Breeding and Physiology, Michael Okpara University of Agriculture, Umudike, PMB 7267, Umuahia, Abia State.

**Corresponding author's email: uceemer@yahoo.com*

Abstract

This study was conducted to investigate the influence of weight group on growth performance and linear body parameters of sigmond strain of Japanese quails. A total of 126 day old chicks were used for the experiment. After brooding for 2 weeks, the chicks were weighed and allotted into 3 different weight groups – heavy (HBW), medium (MBW) and light (LBW). Each group as a treatment was replicated 3 times with 14 chicks/replicate in a completely randomized design. Performance parameters measured were feed intake (FI), daily weight gain (DWG), feed conversion ratio (FCR) and mortality. Linear body traits namely body weight, breast girth, shank length, keel length and wing length were measured at weeks 2, 4 and 6. Multiple regressions were fitted to the data to predict body weight of birds from the linear body traits at 2, 4 and 6 weeks. The HBW had significantly ($P < 0.05$) higher FI (32.81 g) and DWG (2.48 g) whereas significantly better FCR (4.72) was noted for the LBW. Significant differences ($P < 0.05$) also existed among the groups for the linear body traits except for keel length. The HBW also had significantly ($P < 0.05$) higher body weight, shank length and wing length compared to the other two groups. Averagely, the values were 89.01 g, 6.38 cm, 3.64 cm and 9.07 cm for body weight, breast girth, shank length and wing length, respectively. The breast girth of HBW and MBW were statistically ($P > 0.05$) similar. The coefficient of determination (R^2) values for the regression equations were all significant ($P < .05$; $P < 0.001$) for the weight groups at the various weeks. The R^2 values were high for the HBW and MBW groups but ranged from medium to high for the LBW. The result of this study suggests that body weight is a major determinant of growth performance of the Japanese quail strain. It was also observed that the linear traits were good estimators of body weight of the Japanese quails.

Running title: Influence of weight group

Keywords: quail, strain, linear body trait, growth performance, weight group

Introduction

Animal growth can be described as changes that occur throughout an animal's life leading to an increase in volume, size, or shape of the animal (Sezer and Tarhan, 2005). These changes are quantified by measurement of body weight and linear body parameters at regular intervals. Folasade and Obinna (2009) reported that growth is normally measured by growth rate (weight gain/day), degree of maturity and body weight at a given age. Several studies have shown that variations in growth pattern are under genetic and environmental control and that differences exist within species (Lilja *et al*., 1985; Carborg *et al*., 2003; Sezer and Tarhan, 2005).

Ibe (1989) noted that the first approach to livestock characterization and improvement, apart from evaluation of its production performance, is the evaluation of body size and conformation. In corroboration, Chambers (1990) reported that body weight at a specific age is probably the most frequently used indicator of growth. According to Momoh and Kershima (2008), body weight is an important attribute that forms the basis for assessing growth, feed efficiency and for making both economic and market decisions in farm animals. Therefore, body weight, linear body measurements and yield traits are important parameters to poultry breeders and processors.

In the Japanese quail, it has been reported that fattening performance and carcass characteristics were affected by length of growth period, genotype, selection, ration, sex and live body weight (Adedokun and Sonaiya, 2002). Some researchers have also reported significant differences ($P < 0.05$; $P < 0.01$) for various carcass traits for different weight groups of quails (Genchev *et al*., 2008; Tarhyel *et al*., 2012). Based on their study on growth and reproduction of breeding Japanese quails, Kashmiri and Oreta (2011) observed that variation in body weight of the birds caused significant anomalies within the data they collected. As such the authors concluded that body weight had a clear-cut bearing on body composition, reproduction and physiological traits, and that the weight of the bird should be duely considered when planning an experiment with Japanese quails. Studies investigating the effect of different body weight of Japanese quails on growth and linear body traits are scanty in literature and in particular in our study environment.

In an organized livestock marketing system, body weight is normally taken to determine the market prices of animals. Indirect method of assessing body weights in animals without recourse to the weighing scales do exist such as the use of body measurements to predict body weight (Gueye *et al*., 1998; Gambo *et al*., 2014). This indirect body weight estimation using linear body measurements has been reported to be practical, faster, easier, and a cheaper approach especially in rural areas where resources are insufficient and the acquisition of expensive electronic sensitive weighing scale is unaffordable (Semakula *et al*., 2011). Estimates of the relationships between body weight and linear measurements are not only important in developing predictive equations, but they could be integrated in genetic improvement strategies to achieve an optimum combination of body weight and good conformation (Chineke *et al*., 2002). Oke *et al*. (2004) reported that estimates of the relationship that exist among body traits provide useful information on the performance, carcass characteristics and productivity of animals.

Japanese quail (*Coturnix coturnix japonica*) production in Nigeria is fairly recent but has become an integral part of the poultry industry even though it is still established at backyard level. There is increased demand for quail products for consumption due to its medicinal properties in curing common ailments affecting human (Sati *et al*., 2012). It has been reported that it has good nutritive value, tender meat with low caloric value and high dry matter (Muthukumar and Dev Roy, 2005).

The objectives of this study, therefore, are to (1) investigate the effect of different body weight groups on the growth performance and linear body traits of sigmond strain of Japanese quails in a humid rain-forest zone of Nigeria and (2) determine the relationship between body weight and linear body parameters of the Japanese quails.

Materials and Methods

Study area

The experiment was conducted at the Poultry Unit, Teaching and Research Farm of Michael Okpara University of Agriculture, Umudike, Abia State. The area is located within the rain-forest agro-ecological zone of Nigeria on latitude 05° 28′, longitude 07° 33′ and at an altitude of 122 m above sea level. It has an annual rainfall of about 2177 mm, monthly ambient temperature range of 22°C - 32°C and relative humidity of 50 – 95% depending on the season.

Management of Experimental Birds

A total of 126 sigmond Japanese quail day old chicks were obtained from a reputable farm in Ibadan, Oyo State. The chicks were brooded for 2 weeks using hurricane lantern and electric bulbs as sources of heat and illumination in a brooder unit well covered with thick white polyethylene material. Broiler starter mash was fed to the chicks during the brooding period. After brooding, the birds were weighed using electronic sensitive weighing scale and allotted into 3 different body weight groups as given in Table 1. Each weight group representing a treatment, was replicated 3 times with 14 chicks per replicate. Compounded ration (19.80% CP and 2859 Kcal/kgME) and water were given *ad libitum* to the birds. Good hygiene and all routine management operations were ensured throughout the experimental period of 6 weeks.

Table 1. Body weight groups/number of chicks per group

Group	Range	Number of chicks
Light	10 – 19 g	42
Medium	20 – 29 g	42
Heavy	30 – 40 g	42

Data Collection and Analysis

The following growth performance parameters were measured in addition to body weight (g):

$$\text{Average feed intake (g/bird/day)} = \frac{\text{Quantity of feed consumed (g)} - \text{Leftover (g)}}{\text{Number of birds/days}}$$

$$\text{Average daily weight gain (g/bird/day)} = \frac{\text{Final live weight (g)} - \text{Initial live weight (g)}}{\text{Number of birds/days}}$$

$$\text{Feed conversion ratio} = \frac{\text{Average daily feed intake (g)}}{\text{Average daily weight gain (g)}}$$

$$\text{Mortality (\%)} = \frac{\text{Number of dead birds}}{\text{Total number of birds}} \times \frac{100}{1}$$

Data were also generated on linear body measurements (breast girth, shank length, keel length and wing length) at 2, 4 and 6 week intervals.

Breast girth: This was taken at the region of breast expansion when positioned ventrally.

Shank length: It was taken as the length of the tarso-metatarsus from the hock joint to the metatarsal pad.

Keel length: This was taken as the length of the keel bone from the V-joint to the end of the sternum.

Wing length: This was measured as the distance between the tip of the phalanges and the coracoids-humerus joint.

Data collected were subjected to analysis of variance using the general linear model of SPSS (2011) statistical software. Significant means were separated with Duncan's New Multiple Range Test (Duncan, 1955). The linear model fitted to the data is as shown below:

$Y_{ij} = \mu + W_i + e_{ij}$

where,

Y_{ij} = single observation

μ = overall mean

W_i = effect of i^{th} weight group

e_{ij} = random error, which is indenpently and identically normally distributed, with zero mean and constant variance, i.e iind$(0,\sigma^2)$.

Multiple linear regression using the same SPSS (2011) statistical package, was done to establish regression equations for predicting body weight from the linear body traits. The model is as follows:

$Y_i = a + b_1X_1 + b_2X_2 + \ldots + b_kX_k + e_i$

where,

Y_i = dependent variable (body weight)

$X_1 \ldots X_k$ = independent variables (breast width, shank length, keel length and wing length).

a = intercept

$b_1 \ldots b_k$ = regression coefficients

e_i = residual

Results and Discussion

Effect of weight group on growth performance traits

The mean and standard error of mean of growth performance traits of the three weight groups of sigmond Japanese quail are given in

Table 2. Significant differences (P < 0.05) were observed in body weight, daily feed intake, daily weight gain and FCR, whereas no significant difference (P > 0.05) among the three weight groups was noted for percent mortality. This result agreed with that of Maiorka *et al*. (2003), who found that broilers with different weights presented distinct growth curves, which resulted in performance differences in favour of heavier chicks. The heavy body weight (HBW) group had significantly increased body weight (147.66 g), daily weight gain (2.48 g), and daily feed intake (32.82) compared with the other weight groups. The values obtained in this study were higher than the findings of Dauda *et al*. (2014) who reported 89.81 g and 2.14 g for body weight and body weight gain in Japanese quail at 6 weeks of age.

Table 2. Mean ± SEM of growth performance traits of the three weight groups of sigmond strain of Japanese quail

	Weight groups			
Trait	Light	Medium	Heavy	SEM
Final body weight (g)	92.70^c	110.04^b	147.66^a	5.84
Daily weight gain (g/bird/day)	1.63^b	1.72^b	2.48^a	0.14
Daily feed intake (g/bird/day)	7.7^c	18.67^b	32.81^a	3.65
Feed conversion ratio	4.72^a	10.85^b	13.23^c	2.32
Mortality (%)	5.56	5.19	4.89	3.36

$^{a-c}$ Means with different superscripts across the rows are significantly different (P < 0.05).
SEM = standard error of mean.

The differences in the body weight of the various groups could be attributed to differences in feed intake and body mass development. Pinchasov (1991) asserted that the better performance obtained for heavy chicks was related to their higher feed intake. In other words, HBW chicks ate commensurately with their body mass and had faster rate of gain. Choi *et al*. (2013) investigated DNA content and morphological characteristics of muscle fibers, in relation to growth performance of a random bred control and heavy weight Japanese quail lines. They concluded that the HBW line had rapid muscle growth rate and a greater muscle mass which is characterized by larger muscle fiber and that this explained the consistently higher body weight of the HBW line. Tarhyel *et al*. (2012) recorded significant ($P < 0.05$) body weight of 146.39 ± 3.01 g, 118.75 ± 0.54 g and 114.77 ± 3.40 g, respectively for heavy, medium and light weight groups. These values corresponded to the values 147.60 g, 110.04 g and 90.70 g obtained in our study for similar weight groups. The slight variation in values may be due to environmental and management differences.

The FCR of the LBW group was significantly better when compared to HBW and MBW groups. Jatoi *et al*. (2013) showed that HBW groups maintained significantly higher body weight while the LW group had better FCR in four strains of Japanese quails of different weight categories. The FCR values recorded in their study for the strains were 45.94, 46.32, 41.89 (Imported), 49.35, 47.92, 41.13 (Local-1), 51.00, 47.63, 44.01 (Local-2) and 46.61, 42.62, 43.93 (Local-3), respectively for heavy, medium and light weight categories. These estimates are quite higher than FCR values observed in our study. Gomes *et al*. (2008) noted that heavy birds presented better FCR only after 36 days of age. The variations in the outcome of these studies emphasizes that there could be strain differences with respect to varying weight group performances. The better FCR by the LMW group in our study indicates less feed requirement and better feed utilization for growth by the quail chicks.

Effect of Weight group on linear body traits.

Table 3 presents means of linear body parameters of the three weight groups of sigmond Japanese quail in the various weeks of measurement. Significant differences ($P < 0.05$) were observed among the weight groups in the various weeks for all the parameters measured except shank length in week 2 and keel length in weeks 4 and 6. The HBW group had significantly ($P < 0.05$) higher values for shank length in weeks 4 and 6, keel length in week 2 and wing length in all the weeks. This again could be as a result of their increased feed intake and body weight gain. The HBW group, however, compared similarly with the MBW group for breast girth, shank length in week 2 and keel length in weeks 4 and 6. Across the weeks, the linear body parameters progressively increased in the different weight groups as expected. This observation is in line with earlier reports. Ojedapo (2013) reported increased growth of the variables: body weight (118.09 – 142.69 g), body length (10.36 – 11.06 cm), shank length (2.53 – 2.97 cm), drumstick (4.95 – 5.82 cm), keel length (6.61 – 6.34 cm) and chest girth (1.71 - 4.02 cm) from 6 – 10 weeks of age in Pharaoh quails. Similarly, Ojo *et al*. (2014) also reported increases in body traits of quails as their age increased. These workers reported a range of 35.23 – 143.78 g, 8.02 – 13.67 cm, 2.31 – 2.96 cm, 0.32 – 0.44 cm and 3.04 – 5.16 cm for body weight, body girth, shank length, shank diameter and drumstick, respectively from 2 – 8 weeks. Dauda *et al*. (2014) obtained consistently increased values for shank length (1.39, 2.19, 2.50. 3.21 and 3.93 cm), body girth (2.15, 3.10, 4.34, 5.38, 5.81 and 6.51 cm) and wing length (3.28, 7.41, 9.90, 12.37, 13.80 and 15.00 cm) at weeks 1, 2, 3, 4, 5 and 6, respectively. Comparatively, the range of values estimated in the various studies is less

in relation to the values obtained in this study, e
except for wing length as reported by Dauda *et. al*. (2014).

Table 3. Means ± SEM of linear body traits of the different weight groups of sigmond strain of Japanese quail in the various weeks

Trait	Week	Weight group			SEM
		Heavy	Medium	Light	
Body weight (g)	2	49.07[a]	46.48[a]	36.03[b]	2.62
	4	70.31[a]	54.43[b]	46.59[b]	2.82
	6	147.66[a]	110.04[b]	92.70[c]	5.84
Average		89.01[a]	70.32[b]	58.44[b]	4.92
Breast girth (cm)	2	5.47[a]	5.11[a]	4.37[b]	0.17
	4	6.38[a]	6.45[a]	5.09[b]	0.19
	6	7.34[a]	7.47[a]	6.80[b]	0.09
Average		6.39[a]	6.35[a]	5.42[b]	0.15
Shank length (cm)	2	2.82	2.79	2.58	0.10
	4	3.77[a]	3.42[ab]	3.24[b]	0.09
	6	4.32[a]	3.96[b]	3.62[c]	0.08
Average		3.64[a]	3.39[ab]	3.25[b]	0.09
Keel length (cm)	2	9.83[a]	8.83[b]	8.83[b]	0.19
	4	10.09	9.99	9.88	0.25
	6	13.27	12.39	12.05	0.37
Average		11.06	10.42	10.26	0.25
Wing length	2	7.68[a]	7.20[ab]	6.52[b]	0.17
	4	8.98[a]	8.19[ab]	7.52[b]	0.23
	6	10.55[a]	8.90[b]	8.61[b]	0.28
Average		9.07[a]	8.09[b]	7.55[b]	0.18

[a-c] Means with different superscripts across the rows are significantly different ($P < 0.05$).
SEM = standard error of mean

The significant differences in the values of the body traits of sigmond Japanese quails established for the different weight groups underscore the importance of selection for heavy body weights. Such a selection across many generations can positively result in increased selection response. Momoh *et al.* (2014) observed a positive genetic correlation between body weight and body traits of Japanese quails.

Regression of body weight on linear body traits

Table 4 indicates the multiple linear regression equations relating body weight to the linear body traits in weeks 2, 4 and 6 for HBW, MBW and LBW groups. The regression coefficients were significant (P < 0.01 or P < 0.05) for all the weight groups in the various weeks. The coefficients of determination (R^2) for the HBW and MBW group were high and ranged from 72.20 – 80.90 % (heavy) and 78.10 – 80.70 % (medium). Those of the LW group ranged from moderate (64.70 %) to high (86.20 %). The R^2 values obtained in this study indicate the accuracy of predictions and the strong reliability of the measured body traits in predicting body weight of Japanese quails in the various weight groups. Ojo *et al*. (2014) regressed body weight of Japanese quails on body length, body girth, wing length, shank length, shank diameter and drumstick at 2, 4, 6 and 8 weeks and observed R^2 values of 67.7 %, 57.2 %, 37.6 % and 41.4 % for the respective weeks. These R^2 values are lower compared to the values recorded in this study.

Table 4. Prediction equation of three body weight groups of sigmond strain of Japanese quail at the various weeks.

Weight group	Prediction equation	R^2 (%)	S.E	SIG
Heavy	BW_2 = 24.623 + 6.490BG -8.462SL+ 0.275KL + 3.709WL	80.90	9.114	***
	BW_4 = -18.051 + 3.074BG + 9.506SL + 5.359KL - 2.852WL	79.40	16.539	***
	BW_6 = -10.590 - 6.557BG + 45.922SL + 1.917KL - 0.385WL	75.20	78.929	***
Mediun	BW_2 = 5.796 + 4.527BG + 10.735SL – 0.069KL – 2.085WL	80.70	9.727	***
	BW_4 = -14.513 + 2.818BG – 2.423SL + 0. 615KL + 6.837WL	78.50	14.737	***
	BW_6 = -36.131 – 0.021BG + 0.705SL + 8.435KL + 9.513WL	78.10	33.794	***
Light	BW_2 = -43.050 + 10.356BG + 10.604SL-2.143KL + 3.682WL	64.70	21.550	*
	BW_4 = -52.318 + 8.068BG + 15.378SL – 0.472KL + 1.500WL	86.20	18.975	***
	BW_6 = -49.365 + 14.822BG – 0.913SL + 2.800KL + 1.804WL	77.80	43.462	*

BW_2, BW_4 and BW_6 = individual body weights at 2, 4 and 6 weeks of age, BG = breast girth, SL = shank length, KL = keel length, WL = wing length.
R^2 = coefficient of determination, S.E = standard error, ***(P < 0.001), *(P < 0.05).

Wawro (1990) reported that more accurate result in predicting body weight can be obtained where several parameters are used as independent variables in the prediction. Sanda *et al*. (2014) regressed body weight of different broiler strains at 10 weeks of age on breast girth, shank length, thigh length and wing span and obtained R^2 values ranging from 55 – 79 % (Arbor Acre), 49 – 76 % (Marshall) and 58 – 67 % (Ross). The authors however, reported that when all the traits were combined as independent variables, the multiple regressions linking the traits recorded higher R^2 values of 0.79, 0.83 and 0.83 for Arbor Acre, Marshall and Ross, respectively. The results of this study suggest that these body parameters are good predictors of body weight of sigmond Japanese quails of the various weight categories at the different stages of growth since the traits accounted for significant high total variation in their body weight.

Conclusion

The results obtained from this study clearly indicated that weight group significantly influenced both growth performance and linear body characteristics of sigmond strain of Japanese quails. The HBW had significantly increased body weight, daily weight gain and daily feed intake. However, the LBW group had significantly better FCR when compared to the HBW and MBW groups. The HBW group also recorded significantly higher breast width, shank length, keel length and wing length in comparison with the other two groups. This suggests that body weight is a major determinant of growth and linear body development in Japanese quails. The R^2 values for the regression equations were significant. The values were very high for the HBW and MBW groups where as the values ranged from medium to high for the LBW group. The result indicated that breast width, shank length, keel length and wing length are good estimators of body weight of sigmond strain of Japanese quail.

References

Adedokun, S.A. and Sonaiya, E.B. (2002). Crossbreeding Nigeria indigenous with Dahlem Red chickens for improved productivity and adaptability. Arch Tier, Dummerstorf. 45: 297-305.

Carborg, O., Kerje, S., Schutz, S., Jacobsson, L., Jensen, P. and Anderson, L. (2003). A global search reveals epistatic interaction between QTL for early growth in the chicken. Genome Res. 13: 413-421.

Chambers, J.P. (1990). Genetics of growth and meat production in chickens. Chapter 25. In: Poultry Breeding and Genetics. Crawford, R. D. (Ed). Elsevier, New York, Tokyo, pp: 1123.

Chineke, C.A., Agaviezor, B., Ikeobi, C.O.N. and Ologun, A.G. (2002). Some factors affecting body weights and measurements of rabbit at pre- and post-weaning ages. Proc. 27th Ann. Conf., Nig.Soc. for Anim. Prod. Akure, Nigeria. Pp. 1-4.

Choi, Y.M., Sarah, D., Shin, S., Wick, M.P., Kim, B.C. and Lee, K. (2013). Comparative growth performance in different Japanese quail lines: the effect of muscle DNA content and fiber morphology. Poult. Sci., 92: 1870-1877.

Dauda, G., Momoh, O.M., Dim, N.I. and Ogah, D.M. (2014). Growth, production and reproduction performance of Japanese quails (*Coturnix coturnix japonica*) in humid environment. Egypt. Poult. Sci. J. 34: 381-395.

Duncan, D.B. (1955). Multiple ranges and multiple F-test. Biometrics. 11: 1-42.

Folasade, O.A. and Obinna, E. (2009). Effect of genotype x sex interaction on growth and some development characteristics of Ross and Anak broiler strains in the high rainforest zone of Nigeria. Asian J. Poult. Sci. 3: 51-56.

Gambo, G.A., Momoh, O.M., Dim, N.I. and Kosshak, A.S. (2014). Body parameters and prediction of body weight from linear body measurements in *Coturnix* quail. Livest. Res. Rural Devpt. 26 (6).

Genchev, A., Michavlov, G., Ribanski, S., Pavlov, A. and Kabakchiev, M. (2008). Meat quality and composition in Japanese quails. Trakia J. Sci. 6: 72.82.

Gomes, G.A., Araújo, L.F., Prezzi, J.A., Savietto, D., Júnior, J.R.S. and Valério, J. (2008). Tempo de fornecimento da dieta pré-inicial para frangos de corte com diferentes pesos ao alojamento. Revista Brasileira Zootecnia. 37: 1802-1807.

Gueye, E.F., Ndiaye, P. and Branckaert R.D.S. (1998). Prediction of body weight on the basis of body measurements in mature indigenous chickens in Senegal. Livest. Res. Rural Devpt. 10 (3).

Ibe, S.N. (1989). Measurement of size and conformation in commercial broilers. J. Anim. Breed. Genet. 21: 51-58.

Jatoi, S.A., Sahota, A.W., Akram, M., Javed, K., Jaspal, M.H., Hussain, J., Mirani, A.H. and Mehmood, S. (2013). Effect of different body weight categories on the productive performance of four crossbred flocks of Japanese quails (*Coturnix coturnix Japonica*). J. Anim. Plant Sci. 23: 7-13.

Kashmiri, L.A. and Oreta, S. (2011). Role of body weight on reproductive and physiological traits in Japanese quail layers (*Coturnix japonica*). Int. J. Poult. Sci. 10: 640-643.

Lilja, C., Sperber, I. and Marks, H.L. (1985). Postnatal growth and organ development in Japanese quail selected for high growth rate. Growth 49: 51-69.

Maiorka, A., Luqueti, B.C. and Almeida, J.G. (2003). Idade da matriz e qualidade do pintinho, In: Macari M, Gonzales E (editores). Manejo da incubação. Jaboticabal: FACTA; pp 361-377.

Momoh, O.M. and Kershima, D.E. (2008). Linear body measurements as predictors of body weight in Nigerian local chickens. J. Agric. Sci, Sci, Environ. Tech. 8: 206-212.

Momoh, O.M., Gamba, D. and Dim, N.I. (2014). Genetic parameters of growth, body, and egg traits in Japanese quails (*Coturnix coturnix japonica*) reared in Southern guinea savannah of Nigeria. J. Appl. Biosci. 79: 6947-6954.

Muthukumar, S.P. and Dev Roy, A.K. (2005). Alternate poultry production in India. An overview. Sadana Publishers. http://www.dairyyearbook.com/poultry

Ojedapo, L.O. (2013). Phenotypic correlation between the external and internal egg quality traits of Pharaoh quail reared in derived savannah zone of Nigeria. J. Biol., Agric. and Healthcare. 3: 80-83.

Ojo, V., Fayeye, T.R., Ayorinde, K.L. and Olojede, H. (2014). Relationship between body weight and linear body measurements in Japanese quail (*Coturnix coturnix japonica*) J. Sci. Res. 6: 175-183.

Oke, U.K., Herbert, U. and Nwachukwu, E.N. (2004). Associations between body weight and some egg production traits in the guinea fowl (*Numida meleagris galeata*). Livest. Res. Rural Devpt. 16 (10).

Pinchasov, Y. (1991). Relationship between the weight of hatching eggs and subsequent early performance of broiler chicks. Brit. Poult. Sci. 32: 109-115.

Sanda, A.J., Olowofeso, O., Adeleke, M.A., Oso, A.O., Durosaro, S.O. and Sanda, M.O. (2014). Heritability and repeatability estimates of some measurable traits in meat type chicken reared for ten weeks in Abeokuta, Nigeria. Int. J. Biol. Vet. Agric. and Food Eng. 8: 12-18

Sati, N.M., Emennaa, P.E., Fagbamila, I.O., Waziri, N.E., Dzikwi, A.A., Musa, U. and Muhammad, M. (2012). Medicinal beliefs among quail farmers and consumers in Northern Nigeria. Proc. 3rd Mediterranean Poultry Conf, Alexandria, Egypt.

Semakula, J.P., Lusembo, D.R., Kugonza, D., Mutetikka, J., Sennyonjo, J.S. and Mwesiqwa, M. (2011). Estimation of live body weight using zoometrical measurements for improved marketing of indigenous chicken in the Lake Victoria basin of Uganda. Livest. Res. For Rural Devpt. 23(170).

Sezer, M. and Tarhan, S. (2005). Model parameters of growth curves of three meat-type Japanese quail. Czech J. Anim. Sci. 50: 22-30.

SPSS (2011). Statistical procedure for social sciences and facilities for release. Version 20.0. Mcgraw-Hill Company, New York.

Tarhyel, R., Tanimomo, B.K. and Hena, S.A. (2012). Effect of sex, colour and weight group on carcass characteristics of Japanese quail. Scientific J. Anim. Sci. 1: 22-27.

Wawro, K. (1990). Usefulness of body weight and size for evaluation of breeding value of turkeys. Acta Acad. Agric. Tech. Suppl. C. 33: 3-10.