Nig. J. Anim. Prod. 2022, 49(1):89-96. https://doi.org/10.51791/njap.v49i1.3404 *Nigerian Journal of Animal Production*

Comparative egg morphometric analysis between Japanese quail and domestic pigeon reared in Calabar, Nigeria

[*1]Okon, B., [1]Ibom, L. A., [1]Dauda, A. and [2]Okon, A. B.

[1]*Department of Animal Science, University of Calabar, Calabar, Nigeria.*

[2]*Ministry of Health, Calabar, Cross River State, Nigeria*

[*]**Corresponding author:** profbasseyokon@gmail.com

Abstract

Pigeon is a common domesticated bird in Nigeria, but is often times reared for shows and consumed only in rare occasions. The eggs of this bird are sizeable and proven to be nutritionally comparable with the eggs of chicken, duck, quail, etc, which are readily and widely consumed by Nigerians. This study was undertaken to analyze the relationship between the morphometric traits of quail and pigeon eggs in order to recommend strategies for improvement and inclusion in the menu of Nigerians. Two hundred each freshly laid eggs collected from 12 weeks old brown Japanese quails and 28 weeks old domestic pigeons on deep litters fed 18% CP and 2700 KcalME/Kg ration and water ad libitum were used for this study. Data were obtained on quality traits such as egg weight (g), shell weight (g), shell thickness (mm), albumen height (mm), albumen width (mm), albumen weight (g), yolk height (mm), yolk weight (g) and yolk width (mm). Pigeon eggs were better for egg weight (16.941 g), shell weight (1.873 g), albumen height (25.463 mm), albumen width (41.370 mm), albumen weight (7.653 g), yolk height (10.668 mm), yolk weight (8.510 g) and yolk width (26.002 mm) than the Japanese quail eggs. Most of the comparatively paired samples (T-values) of morphometric traits obtained though negative, but highly significant ($p<0.001$) were also in favour of pigeon eggs for egg weight (– 6.746), shell weight (– 0.594), albumen height (– 21.265), albumen width (– 11.149), albumen weight (– 3.383), yolk weight (– 4.070), yolk height (– 0.400) and yolk width (– 3.071) than the Japanese quail eggs, except only shell thickness with positive T-value of 0.071 and mean value of 0.928 mm which were better for Japanese quail eggs. Most of the correlation coefficients obtained from paired internal egg quality traits for both birds were non-significant ($p>0.05$) and either positively or negatively low. Comparatively the only positive, significant ($p<0.05$) correlation coefficients were recorded between albumen height (AH) and yolk weight (YW) (0.564) for quail egg traits and between albumen height (AH) and yolk weight (0.633) for the pigeon egg traits. Thus, it can be concluded that pigeon eggs were better than quail eggs for most of the egg morphometric traits evaluated.

Keywords: Comparative, egg morphometric, quail, pigeon, Calabar

Analyse morphométrique comparative des œufs entre la caille japonaise et le pigeon domestique élevés à Calabar, Nigéria

Résumé

Le pigeon est un oiseau domestique commun au Nigeria, mais il est souvent élevé pour des spectacles et consommé seulement en de rares occasions. Les œufs de cet oiseau sont de grande taille et se sont avérés nutritionnellement comparables aux œufs de poulet, de canard, de caille, etc., qui sont facilement et largement consommés par les Nigérians. Cette étude a été entreprise pour analyser la relation entre les traits morphométriques des œufs de caille et de pigeon afin de recommander des stratégies d'amélioration et d'inclusion dans le menu des Nigérians. Deux cents œufs fraîchement pondus prélevés sur des cailles japonaises

brunes âgées de 12 semaines et des pigeons domestiques âgés de 28 semaines sur des portées profondes nourries avec 18% de CP et une ration de 2700 KcalME / Kg et de l'eau à volonté ont été utilisés pour cette étude. Des données ont été obtenues sur des caractères de qualité tels que le poids de l'œuf (g), le poids de la coquille (g), l'épaisseur de la coquille (mm), la hauteur de l'albumen (mm), la largeur de l'albumen (mm), le poids de l'albumen (g), la hauteur du jaune (mm), poids du jaune (g) et largeur du jaune (mm). Les œufs de pigeon étaient meilleurs pour le poids de l'œuf (16,941 g), le poids de la coquille (1,873 g), la hauteur de l'albumen (25,463 mm), la largeur de l'albumen (41,370 mm), le poids de l'albumen (7,653 g), la hauteur du jaune (10,668 mm), le poids du jaune (8,510 g) et la largeur du jaune (26,002 mm) que les œufs de caille japonais. La plupart des échantillons relativement appariés (valeurs T) de traits morphométriques obtenus bien que négatifs, mais hautement significatifs ($p<0,001$) étaient également en faveur des œufs de pigeon pour le poids des œufs (– 6,746), le poids de la coquille (– 0,594), la hauteur de l'albumen (– 21,265), la largeur de l'albumen (– 11,149), le poids de l'albumen (– 3,383), le poids du jaune (– 4,070), la hauteur du jaune (– 0,400) et la largeur du jaune (– 3,071) que les œufs de caille japonaise, sauf seulement l'épaisseur de la coquille avec valeur T positive de 0,071 et valeur moyenne de 0,928 mm qui étaient meilleures pour les œufs de caille japonaise. La plupart des coefficients de corrélation obtenus à partir des caractéristiques internes appariées de la qualité des œufs pour les deux oiseaux étaient non significatifs ($p>0,05$) et positivement ou négativement faibles. Comparativement, les seuls coefficients de corrélation positifs et significatifs ($p<0,05$) ont été enregistrés entre la hauteur de l'albumen (HA) et le poids du jaune (PJ) (0,564) pour les caractères de l'œuf de caille et entre la hauteur de l'albumen (HA) et le poids du jaune (0,633) pour le pigeon. caractéristiques des œufs. Ainsi, on peut conclure que les œufs de pigeon étaient meilleurs que les œufs de caille pour la plupart des traits morphométriques des œufs évalués.

Mots-clés : Comparatif, morphométrie des œufs, caille, pigeon, Calabar

Introduction

Morphometrics, generally refers to the quantitative measurements of the body parts. It deals with the statistical test of hypotheses about the factors that affect shape. The knowledge and information on morphometric parameters provide essential and clearer understanding about the animal. It can be used to quantify a trait of evolutionary significance as well as detect changes in its shape. Egg morphometric trait comprises of the external egg quality (size and shell weight) and egg internal quality traits (yolk and albumen qualities) (Okon *et al*., 2020). Egg quality according to Abdulraheem *et al*. (2018) is the most important price-contributing factor in both table and hatching eggs, as it portrays the characteristics of an egg that affects its acceptability to the consumer. Thus, the authors opined that economic success of a laying flock depends solely on the number of quality eggs produced. Quality traits of eggs determine prices directly in commercial and in egg processing enterprise, the weight of egg shell, albumen and yolk that form the egg as well as their compositions affect the amount and price of the product (Altan *et al*., 1998). Egg is known as the most important component of human diet (Amao and Olugbemiga, 2016) and one of the most nutritious and complete food known to man. The egg according to Odetola *et al*. (2017) provides means through which animal protein requirements of the populace can be met and it has various uses including containing many essential nutrients and supports life during embryonic growth. Japanese quails are small body sized, early sexually maturing,

hardy, prolific with high rate of production between 290 and 300 eggs per year, short generation time, low maintenance cost of less feed requirement of 20 – 25 g per day and attain market weight at the same age (Ukoha and Onunkwo, 2017; and Raji and Mbap, 2017). Besides, they have high resistance to common poultry diseases (Hassan *et al*., 2003). The female lay small white spotted with black eggs of less than 15 g compared to egg laying chicken of about 40 – 70 g. Quail egg is lower in cholesterol as compared to chicken (Musa *et al.,* 2008). Comparatively, chicken egg contains 4% cholesterol and quail egg has only 1.4%, 3 times less fats, less 2% protein, while the chicken yolk has about 16 – 17% (Mustafa *et al.*, 2009). Domestic pigeons (*Columba liviadomestica*) are adaptable birds that can be raised with little capital input and are able to survive in harsh condition. Female pigeons reach sexual maturity as early as 7 months of age, 8 – 12 days after mating the females lay 1 – 3 (usually 2) white eggs every forth night which hatch after 18 days. Pigeon egg measures about 3 cm long and has a smooth surface with a porcelain-white shell. The shell of a pigeon egg is as thin as paper and very crispy. It breaks as soon as it takes a hit. Adeyeye (2012) noted that in Nigeria, more emphasis is laid on domestic fowl to the neglect of other classes of poultry such as duck, pigeon and goose eggs, the small eggs such as quail eggs and the largest bird eggs from ostriches. According to Sun *et al*. (2019), besides the usual poultry species, other classes such as duck, goose, turkey, quail and pigeon should also be paid attention to as their properties would be helpful in technological and function application of egg albumen from different poultry species. There is very limited number of reports on comparative egg morphometric analyses between Japanese quails and domestic pigeons in literature. This study was undertaken to provide information on comparative morphometric traits of both eggs which according to Kabir *et al*. (2012) is also vital for an understanding of fertility, development of embryo, egg quality and disease of poultry and other pet birds.

Materials and methods

Location of study

The study was conducted at a private farm (BATONIA FARM) in Calabar, a farm approved by the Department of Animal Science, University of Calabar for students to undertake their studies. Calabar is located in South-South region of Nigeria at latitude 4^{o} 5' N of equator and longitude 8^{o} 19' E of the Greenwich meridian with annual rainfall range from 1260 – 1280 mm, annual temperature ranging from 25^{o} – 30^{o}C with relative humidity of 70 – 90% and at an elevation above sea level of 98 meters (NMA, 2018).

Sample collection

A total of 200 freshly laid eggs were collected from a foundation stock of domestic pigeons aged 28 weeks. The pigeons were housed in a 40 cm x 40 cm x 25 cm wooden cage provided with a nest. Similarly, a total of 200 freshly laid eggs were collected from a foundation stock of brown Japanese quails aged 12 weeks. The pigeons and quails were fed ration containing 15% CP and 2700 KcalME/Kg and water *ad libitum*. Constant and regular sanitation of the pens and cages including the nest and feeders for both birds were carried out as at when due.

Measurement of egg quality

Data measured on external quality traits included egg weight (EW), shell weight (SW) and shell thickness (ST). An electronic scale, Scout™ pro-scale with 0.001 g to 1000 g sensitivity was used to measure weight, while Vernier caliper was used to measure lengths and widths. Average shell thickness was obtained from average values of the sample taken from

sharp, blunt and pointed parts of the egg shell using Micrometer screw gauge (mm). Parameters measured on internal egg traits werealbumen weight (AW), albumen height (AH), albumen width (AD), yolk weight (YW), yolk height (YH) and yolk width (YD). Yolk and albumen heights and widths were determined using a spherometer calibrated in millimeters (mm).

Statistical analysis

All data collected for external and internal egg traits were analyzed for simple statistics (mean, standard deviation, standard error and coefficient of variation) and T-test. The data were analyzed using the model:

$$Y_{ij} = U + T_i + e_{ij}$$

where:

Y_{ij} = Individual observation on eggs

U = Overall mean

T_i = Fixed effect of i^{th} eggs (i = 1, 2)

e_{ij} = Residual random error

Phenotypic correlations among egg weight and egg linear traits were determined with Pearson's correlation coefficients (r) using SPSS (2015). The model for the Pearson's correlation was:

where: $r = \frac{\sum X_i Y_j}{\sqrt{\sum X_i^2 \sum Y_j^2}}$

r = Pearson's correlation

X_i = First random variable of the i^{th} egg weight of egg trait

Y_i = Second random variable of the i^{th} egg linear trait

Results and discussion

The results of the description of sampled population are presented in Table 1. Domestic pigeon had higher values for measured quantitative traits with 16.941 g, 1.873 g, 25.463 mm, 41.379 mm, 7.653 g, 10.668 mm, 8.510 g and 26.002 mm for egg weight, shell weight, albumen height, albumen width, albumen weight, yolk height, yolk weight and yolk width than the eggs from Japanese quail, except for shell thickness with lower value of 0.857 mm.

Table 1: Summary of descriptive statistics of morphometric traits in Japanese quails and domestic pigeons

		Japanese quails			Domestic pigeons		
Morphometric traits	**N**	$\bar{X}$±SE	**SD**	**CV%**	$\bar{X}$±SE	**SD**	**CV%**
Egg weight (g)	200	10.195±0.175	0.781	7.664	16.941±0.146	0.655	3.867
Shell weight (g)	200	1.280±0.022	0.100	7.822	1.873±0.036	0.162	8.633
Shell thickness (mm)	200	0.928±0.019	0.086	9.247	0.857±0.022	0.088	10.257
Albumen height (mm)	200	4.198±0.039	0.175	4.164	25.463±0.282	1.261	4.952
Albumen width (mm)	200	30.230±0.135	0.608	2.011	41.379±0.148	0.661	1.598
Albumen weight (g)	200	4.270±0.105	0.471	11.041	7.653±0.166	0.744	9.721
Yolk height (mm)	200	10.268±0.098	0.438	4.267	10.668±0.079	0.353	3.313
Yolk width (mm)	200	22.931±0.120	0.538	2.348	26.002±0.054	0.242	0.929
Yolk weight (g)	200	4.441±0.118	0.529	11.917	8.510±0.501	2.240	26.327

N = Sample size, $\bar{X}$ = Mean, SE = Standard Error, SD = Standard Deviation, CV = Coefficient of Variation, % = Percent

These results indicated that the quantitative traits on both eggs of Japanese quail and domestic Pigeon are breed dependent. There were large disparities which were significantly ($p<0.001$) different between the means of external traits (egg weight and shell weight) and internal traits (yolk weight and width, and albumen qualities: weight, height and width) between Japanese quail and domestic pigeon eggs (Table 2). Comparative highly negative significant ($p<0.001$) values were recorded for paired samples test (T-test) between egg weights, shell weights, shell thickness, albumen heights, albumen widths, yolk heights, yolk weights and yolk widths between the quail and pigeon eggs (Table 2).

Table 2: Paired samples test of morphometric traits be tween Japanese qu ails and domestic pigeons

Paired morphometric traits	t-values	Significant level
JQ – EW/DP – EW	– 6.746	0.001^{***}
JQ – SW/DP – SW	– 0.594	0.001^{***}
JQ – ST/DP – ST	0.071	0.014^{NS}
JQ – AH/DP – AH	– 21.265	0.001^{***}
JQ – AD/DP – AD	– 11.149	0.001^{***}
JQ – AW/DP – AW	– 3.383	0.001^{***}
JQ – YH/DP – YH	– 0.400	0.003^{NS}
JQ – YW/DP – YW	– 4.070	0.001^{***}
JQ – YD/DP – YD	– 3.071	0.001^{***}

JQ = Japanese QUail, DP = Domestic Pigeon, EW = Egg Weight, SW = Shell Weight, ST = Shell Thickness, AH = Albumen Height, AD = Albumen Width, AW = Albumen Weight, YH = Yolk Height, YW = Yolk Weight, YD = Yolk Width
*** = Significant (P<0.001), ^{NS} = Non-Significant

This indicated that domestic pigeon eggs had genetically heavier, higher and wider mean values than Japanese quail eggs, as confirmed by highly significant (T-test) difference for most of the paired traits between the two birds (Table 2). These results agreed with the results of Kabir *et al*. (2012) that recorded heavier, higher and wider mean values for egg weights (2.73 g, 2.41 g), shell weights (2.40 g, 2.20 g), albumen weights (6.30 g, 3.70 g) and Sun *et al*. (2019) for egg weights (22.57 g, 11.01g) and albumen weights (16.62 g, 6.71 g), respectively between pigeon eggs and quail eggs. The results of this study on shell thickness that recorded higher mean egg shell thickness of 0.928 mm for the quail eggs than mean egg shell thickness of 0.857 mm for pigeon eggs also agreed with the reported mean egg shell thickness of 0.193 mm for quail egg and 0.180 mm for pigeon egg reported by Sun *et al*. (2019). This is in accordance with the view that pigeon egg shell is as thin as paper. Besides, the difference in the results (Table 1) obtained might be attributed to the fact that domestic pigeons are larger and bigger (7 months) than the quails 3 months at maturity. Again, it might be due to the size and wider spread of egg weights range of pigeon than those of quail differential expression of genes by different birds and breed effect (Hanusova *et al*., 2015 and Sun *et al*., 2019). Internal egg traits such as albumen and yolk weights are very important from nutritional and health view point (Kabir *et al*., 2012). In this regards, pigeon eggs that showed higher albumen weight (7.653 g) and yolk weight (8.510 g) than the Japanese quail eggs with lower albumen weight (4.270 g) and yolk weight (4.441 g) could be considered preferable (Kabir *et al*., 2012). The comparatively observed higher values of albumen contents albumen weight (7.653 g), yolk weight (8.510 g) for pigeon; albumen weight (4.270 g) and yolk weight (4.441 g) for quail was in harmony with the observations of Sun *et al*. (2019). The coefficient of variation (CV %) indicate the level of variation present for a measurement. High variability of 26.327% and 11.917% for yolk weights of pigeon and quail eggs, respectively indicated the possibility of improving this trait through selection (Chi and Shi, 2002). Phenotypic correlation (r_p) coefficients obtained for internal egg traits of Japanese quail and domestic pigeon eggs are shown in Table 3. Interestingly, most of the correlation coefficients obtained from paired internal egg quality traits of both birds were non-significant ($p>0.05$) and either positively or negatively low. These results are in agreement with the low, non-significant

($p>0.05$) reports of Ojedapo (2013) for internal egg quality traits. But very high, negative significant ($p<0.01$) correlation coefficients obtained (Table 3) between yolk weight (YW) and albumen width (AD) (– 0.802) and moderate, negative significant ($p<0.05$) correlation coefficient between albumen height (AH) and albumen width (AD) (– 0.561) for quail internal egg traits. Similarly, very high, negative significant ($p<0.01$) correlation coefficient was obtained (Table 3) between yolk weight (YW) and yolk width (YD) (– 0.816), and moderate, negative significant ($p<0.05$) correlation coefficients between albumen height (AH) and albumen width (AD) (– 0.627), between albumen height (AH) and yolk height (YH) (– 0.506) and between albumen width (AD) and yolk height (YH) (– 0.523) for pigeon internal egg traits. Comparatively, the only moderate positive, significant ($p<0.05$) correlation coefficients were between albumen height (AH) and yolk weight (YW) (0.564) for the quail egg traits and between albumen height (AH) and yolk weight (YW) (0.632) for the pigeon internal egg traits. These positive correlations signified that the traits are controlled by same gene and showed an indication that any of these egg traits could serve as a predictor of egg weight. Again, Chi and Shi (2002) noted high phenotypic correlations which probably showed that the traits have common genomic sites for their genetic control and as well showed that stepwise multiple linear regression is a better predictor of egg weight using these traits.

Consequently, Ige (2013) opined that correlation coefficients indicate the strength of linear association between traits, thereby give useful information of traits involved for the purpose of breeding and improvement plan.

Table 3: Phenotypic correlation coefficients (r_p) of morphometric traits of Japanese quails and domestic pigeons

			Domestic pigeons			
Morphometric traits	**YW**	**AH**	**AW**	**AD**	**YH**	**YD**
YW		0.632^{*}	-0.320^{NS}	-0.362^{NS}	– 0.101	-0.816^{**}
AH	0.564^{*}		– 0.627	– 0.094	-0.506^{*}	-0.486^{NS}
AW	-0.074^{NS}	-0.230^{NS}		– 0.089	0.497^{NS}	0.158
AD	-0.802^{**}	-0.561^{*}	-0.330^{NS}		-0.523^{*}	– 0.146
YH	0.213^{NS}	-0.136^{NS}	0.468^{NS}	-0.345^{NS}		0.153
YD	– 0.296	-0.015^{NS}	0.289^{NS}	-0.196^{NS}	-0.345^{NS}	
	YW	**AH**	**AW**	**AD**	**YH**	**YD**
			Japanese quails			

YW = Yolk Weight, YH = Yolk Height, YD = Yolk Width, AH = Albumen Height, AW = Albumen Weight, AD = Albumen Width

** = Significant ($P<0.01$), * = Significant ($P<0.05$), ^{NS} = Non-Significant

Conclusion

This study revealed the comparative data of egg morphometric analyses, and phenotypic correlations of Japanese quails and domestic pigeons. Pigeon eggs were better than quail eggs for most egg quality traits studied, except for shell thickness. Most of the comparative paired samples (T-values) of morphometric traits obtained were negative. Besides, the pigeon eggs also performed better (recorded higher values) in other phenotypic traits evaluated. It could therefore be concluded that strategies for improving this bird (pigeon) be advanced for their inclusion in the menu of Nigerians.

References

Abdulraheem, A. O., Alade, N. K., Aliyu, J., Raji, A. O. and Augustine, C. 2018. Heritability estimates of external egg quality characteristics of Japanese quails raised under semi-arid environment of Borno State, Nigeria. *Nigerian Journal of Animal Science and Technology*. 1(1):60 – 66.

Altan, O. I., Oquz, I. and Akbas, Y. 1998. Effects of Selection of high body weight and egg of hen on egg characteristics in Japanese quail (*Coturnixcoturnix japonica*). *Turkis Journal of Veterinary Animal Science*, 2:67 – 93.

Adeyeye, E. I. 2012. Nutritional values of the lipid composition of the free-range chicken eggs. *Agriculture and Biology Journal of North America*, 3(9):374 – 384.

Amao, S. R. and Olugbemiga, K. S. 2016. A study of quality traits of duck and Goose eggs selected from different areas of Oyo Metropolis, South Guinea Zone of Nigeria. *Continental Journal of Agricultural Science*, 10(1):1 – 7.

Chi, M. X. and Shi, S. K. 2002. Phenotypic factors analysis for Linear type traits in Beijing Holstein Cows. Institute of Animal Science, Chinese Academy of Agricultural Science, Beijing, 1527 – 30.

Hanusova, E., Hincar, C., Hanus, A. and Oravcova, M. 2015. Effect of breed on some parameters of egg quality in laying hens. *Actafytotechn. Zootechno*, 18(1):20 – 24.

Hassan, S. M., Mady, M. E., Cartweight, A. L., Sabri, H. M. and Mobarak, M. S. 2003. Effect of acetyl salicyclic acid in drinking water on reproductive performance of Japanese quail (*Coturnixcoturnix japonica*). *Poultry Science*, 82:1174 – 1184.

Ige, A. O. 2013. Relationship between body weight and growth traits of crossbred Fulani ecotype chicken in derived savannah zone of Nigeria. *International Journal of Agricultural Research*, 9:157 – 166.

Kabir, M. A., Islam, M. S. and Dutha, R. K. 2012. Egg morphometric analysis in chickens and some selected birds. *University Journal of Zoology*, Rajshahi University, 31:85 – 87.

Musa, U., Haruna, E. S. and Lombin, L. H. 2008. How to start Quail Production. In: *Quail Production in the Tropics*. 1st edition, National Veterinary Research Institute Press, Vom, Nigeria. Pp. 10 – 14.

Mustafa, M., Ismail, B., Handan, E., Sadi, C. I., Serkan, C., Eda, C. and Mustafa, K. 2009. The effect of dietary poppy seed oil and sun flower oil on performance, reproduction, egg quality parameter and fatty acid profile of egg yolk in the Japanese quail. *Journal of Animal and Veterinary Advances*, 8(2):379 – 384.

NMA 2018. Nigerian Meteorological Agency. An online Meteorological agent. www.nima.gov.gov.ng

Odetola, O. M., Adejinmi, O. O., Akingbade, A. O. and Adekanmbi, A. O. 2017. Performance and egg quality parameters of Japanese quail (*Coturnixcoturnix japonica*) fed Kenaf (*Hibiscus cannabinus*L.) seed based diets subjected to varying cooking periods. *Nigerian Journal of Animal Production*. 44(4):225 – 231.

Ojedapo, L. O. 2013. Phenotypic

correlation between the external and internal egg quality trait of Pharaoh quail reared in Derived Savannah zone of Nigeria. *Journal of Biology, Agriculture and Healthcare*, 3(10):80 – 83.

Okon, B., Ibom, L. A., Dauda, A. and Ebegbulem, V. N. 2020. Egg quality traits, phenotypic correlations, egg and yolk weights prediction using external and internal egg quality traits of Japanese quails reared in Calabar, Nigeria. *International Journal of Molecular Biology*. 5(1):21 – 26.

Raji, A. O. and Mbap, S. T. 2017. Genetic analysis of body weights of Japanese quails (*Coturnix japonica*) in a semi-arid area of Nigeria. *Nigerian Journal of Animal Production*. 44(1):30 – 38.

SPSS 2015. Statistical Package for Social Sciences, SPSS Inc.

Sun, C., Liu, J., Yang, N. and Xu, G. 2019. Egg quality and egg albumen property of domestic chicken, duck, goose, turkey, quail and pigeon. *Poultry Science*. 98:4516 – 4521.

Ukoha, O. A. and Onunkwo, D. W. 2017. Effects of NutMeg (*Monodoramyristica*) spice in aflatoxin-infected diets on growth performance of Japanese quails (*Coturnixcoturnix*). *Nigerian Journal of Animal Production*. 44(1):290 – 295.

Received: 3rd November, 2021
Accepted: 17th February, 2022