

Repeatability estimates of external and internal egg quality traits in Japanese quail

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Target Audience: Quail farmers, Geneticists

Abstract

Twenty-five (25) freshly laid Japanese quail (*Cortunix japonica*) eggs, randomly selected weekly for 7 weeks from the base population of 249 birds were used to estimate the repeatability of external and internal egg quality traits. External egg quality traits were Egg Weight (EWT), Egg Length (EL), Egg Width (EW), Shell Weight (SWT) and Shell Thickness (ST). Internal egg traits were Yolk Height (YH), Yolk Diameter (YD), Albumen Height (AH), Albumen Diameter (AD), Yolk Weight (YWT) and Albumen Weight (AWT). Variance components and Repeatability estimates were obtained using the one-way Analysis of Variance (ANOVA) with the Computer aided Software, Statistical Analysis System (SAS, version 8). High repeatability estimate (0.76) was observed for egg weight. Only egg weight would require a maximum of 7 records to characterize the inherent producing ability of each hen. Selection for improvement using egg weight will result in good performance and significant genetic gain. More records would be needed to achieve this for other external and internal egg quality traits. From this study Egg weight should therefore be adopted as the key determinant for repeatability estimations in Japanese quail.

Key words: Japanese quail, Egg traits, Internal, External, Repeatability

Description of Problem

Japanese quail (*Cortunix japonica*) has assumed worldwide importance not only as a laboratory animal due to its extensive use in studies for growth, selection and breeding, but also as a supplier of meat and eggs particularly for the rural poor [1, 2]. The advantages of Japanese quail over other types of birds used for biological and genetic studies are immense, including its small body size, easy handling, disease resistance, less capital requirement, early sexual maturity, which results in short generation interval, high rate of lay and much lower feed and space requirements. Quail meat is renowned to be highly delicious and nutritive, has low caloric value and high dry matter, and is preferred by many [3]. It is also

rich in protein, vitamins, essential amino acids, saturated and unsaturated fatty acids as well as phospholipids. Increased protein intake is desired because Nigerians consume only 5.5 g of animal protein per person per day which is far below the recommended level [4].

Among the many quality characteristics of Japanese quail, external parameters including cleanliness, freshness, egg weight and shell weight determine consumer acceptability of the eggs [5]. Interior characteristics such as yolk height, Haugh unit and chemical composition are also important. External and internal quality traits of eggs are significant in poultry breeding business because of their influence on the yield features of future generations and the overall breeding

performances [6]. Udoh *et al.* [7] therefore posited that it is necessary to implement a total quality management programme to maintain consistently good quality throughout the egg production cycle.

In view of the importance of this small stock, it is therefore necessary to initiate improvement programmes that can genetically develop the birds for efficient and effective productivity. Repeatability is the ability of individuals to repeat their performance and maintain their ranking in a population in successive records. Thus, whereas traits such as birth weight and slaughter weight are measured once during the life time of an animal, others like body weight and egg quality can be measured several times [8]. Early estimation of the most probable producing ability of each quail is of immense advantage from the point of view of its shortened generation interval as it enhances the expected rate of genetic gain per generation.

The objectives of this study therefore, were (i) to identify key external and internal egg quality traits for use in repeatability estimates (ii) to determine the repeatability estimates of external and internal egg quality traits in Japanese quail.

Materials and Method

Experimental Site

The study was conducted at the Poultry Breeding Unit of the Teaching and Research Farm in the Department of Animal Science, Faculty of Agriculture, University of Uyo, Uyo, Akwa Ibom State, Nigeria. The area is geographically located on latitude 05⁰²'N and longitude 07⁰⁵⁶'E, at an altitude of 38 metres above sea level. It is a humid environment with a mean annual rainfall ranging from 2000 millimetres to 3000 millimetres. Uyo has a natural day length of 12 hours to 13 hours, a monthly mean minimum temperature range of between 21.3⁰C and 24.9⁰C, a mean maximum temperature range of

between 28.4⁰C and 34.5⁰C and a relative humidity range of 78% to 93% [9].

Acquisition of Experimental Birds

Fertile quail eggs were acquired from a random bred population at the National Veterinary Research Institute (NVRI), Vom, Plateau State, Nigeria. They were incubated in Uyo with Model 1520 Sportman digital thermostat-equipped incubator at a temperature of 37.78⁰C and humidity range of between 45% and 55%. The eggs were hatched artificially within 16 to 18 days to obtain the base population of quail chicks.

Management of Experimental Birds

Pens were cleaned, bedded with wood shaving and equipped with drinkers, feeders and electric bulbs in preparation for brooding. At hatch, chicks were carefully handpicked and transferred in small groups into the brooding pens. Chicks were brooded for three (3) weeks under room temperature of 35⁰C. Daily washing and refilling of drinkers and feeders as well as the weekly replacements of wood shavings were done to avoid contaminations and related health hazards. Prophylactic medications were administered against prevalent poultry infections. Multivitamin preparations were administered in drinking water to boost appetite. The principles of animal care were adhered to strictly, throughout the duration of the study.

Multiple lay ^(R) was incorporated into their feed at the 8th week to enhance egg production. Birds received *ad libitum* feed and water. Three types of feed were provided: chick starter mash with 22% CP and ME of 3000 Kcal/kg (0 – 3 weeks); grower mash with 15% CP and ME of 2500 kcal/kg (3 – 6 weeks) and layer mash with 16.8% CP and ME of 2680 kcal/kg (6 – 14 weeks). Birds were sexed before being transferred to battery cage rearing apartment at the end of 3 weeks. Mating occurred at random at a male to female ratio of

1:3. There were therefore 83 males and 166 females, giving a total of 249 quails in the experimental population. Freshly laid eggs were collected twice daily (8.00am and 4.00pm) and carefully conveyed to Animal Science Department's laboratory storage facility, in preparation for laboratory analysis.

Data Collection

Twenty-five (25) freshly laid eggs were randomly selected weekly for seven (7) weeks to determine their external and internal egg characteristics. Altogether, 175 eggs were assessed during weeks 7, 8, 9, 10, 11, 12 and 13 for repeatability estimates.

a) Measurement of External Egg Parameters

- i. Egg weight (EWT):- egg were numbered, labeled and weighed on an OHAUS digital electronic scale with sensitivity of 0.01 g.
- ii. Egg Length (EL):- measured using vernier calipers to the nearest 0.01 mm.
- iii. Shell Weight (SWT):- eggs were carefully broken and poured on to a clean glass surface for the shell to be weighed with an OHAUS digital electronic scale with a sensitivity of 0.01 g.
- iv. Shell Thickness (ST):- the egg shells were collected and oven dried for 24 hours after which a micrometer screw gauge was used to measure the thickness of the shells to the nearest 0.01 mm.

b) Measurement of Internal Egg Parameters

- i. Yolk Height (YH), Yolk Diameter (YD), Albumen Height (AH):- measured with vernier calipers to the nearest 0.01 mm.

- ii. Yolk Weight (YWT):- yolk was carefully separated from the albumen by spoon-scooping it on to a plate and then weighed with an OHAUS digital electronic scale with a sensitivity of 0.01 g.
- iii. Albumen Weight (AWT):- obtained by subtracting the shell value from the yolk weight.

Statistical Analysis

Variance components and repeatability estimates for external and internal egg quality traits were obtained using the one-way analysis of variance (ANOVA). The computer-aided software, Statistical Analysis System (SAS, version 8), was used to generate the different values for individual variance components, error variance, F value and probability value for each of the test variables.

The repeatability estimate (R) was derived using the following expression as described by Becker (1984).

$$R = \frac{V_I}{V_I + V_e}$$

Where

V_I = variance component due to difference among individual bird

V_e = error variance component within flock

Formular for calculating standard error of the estimates was done using the following formular as described by Becker (1984):

$$SE(R) = \sqrt{\frac{2}{k}}$$

Where k is the number of measurements taken on each individual, k is the total number of measurements on n individuals, $k_1 = 1/n-1$ ($k - \sum k^2_i/k$)

Where k_i is the number of measurements taken on ith individual.

Table 1. Mean Values for External Egg quality Traits in Japanese Quail

Age (week)	EWT (g)	EW (mm)	EL (cm)	SWT (g)	ST (mm)
7	7.792 ^d	2.275 ^e	2.830 ^e	0.700 ^e	0.524 ^a
8	9.492 ^c	2.421 ^d	3.038 ^d	0.856 ^d	0.524 ^a
9	9.456 ^c	2.467 ^c	3.022 ^d	0.900 ^c	0.524 ^a
10	10.064 ^b	2.633 ^a	3.095 ^b	0.980 ^b	0.525 ^a
11	10.344 ^a	2.505 ^{ab}	3.092 ^b	1.092 ^a	0.524 ^a
12	10.390 ^a	2.521 ^b	3.140 ^a	1.088 ^a	0.524 ^a
13	10.024 ^b	2.475 ^c	3.065 ^c	1.064 ^{ab}	0.525 ^a
SE	0.31	0.11	0.05	0.15	0.00

EWT = Egg Weight; EW = Egg width; EL = Egg Length; SWT = Shell Weight; ST = Shell Thickness
^{a, b, c, d, e} Mean along columns bearing different superscripts are significantly different (P<0.05)

Table 2. Mean Values for Internal Egg quality Traits in Japanese Quail

Age (week)	YH (mm)	YD (cm)	YWT (g)	AH (mm)	AD (cm)	AWT (g)
7	0.909 ^d	2.167 ^e	2.356 ^f	0.430 ^b	3.439 ^d	1.656 ^g
8	0.959 ^b	2.305 ^c	2.772 ^d	0.435 ^b	4.203 ^f	1.916 ^d
9	0.958 ^b	2.338 ^b	2.792 ^e	0.340 ^{cd}	4.357 ^e	1.892 ^e
10	0.977 ^a	2.582 ^a	3.116 ^b	0.517 ^a	4.360 ^e	2.136 ^b
11	0.951 ^b	2.255 ^d	3.284 ^a	0.356 ^c	4.509 ^c	2.192 ^a
12	0.975 ^a	2.295 ^c	3.068 ^c	0.345 ^c	4.656 ^b	1.972 ^c
13	0.944 ^c	2.325 ^b	2.848 ^d	0.388 ^d	4.795 ^a	1.784 ^f
SE	0.02	0.25	0.17	0.11	0.13	0.05

YH = Yolk Height; YD = Yolk Diameter; YWT = Yolk Weight; AH = Albumen Height;
 AD = Albumen Diameter; AWT = Albumen Weight
^{a, b, c, d, e} Mean along columns bearing different superscripts are significantly different (P<0.05)

Results

External Egg Quality Traits in Japanese Quail

Mean values for external egg quality traits in Japanese quail at weeks 7, 8, 9, 10, 11, 12 and 13 laying periods are presented in Table 1. Although lowest values were recorded for all external egg quality traits at week 7, there was no indication that the values increased with age. However, the peak was observed in the 13th week. There was however some significant differences (P<0.05) among traits with age. This is as seen in EWT, EW,

EL and SWT (external traits), YH, YD, YWT, AH, AD, and AWT (internal traits)

Internal Egg Quality Traits in Japanese Quail

Mean values for internal egg quality traits in Japanese quail at weeks 7, 8, 9, 10, 11, 12 and 13 laying periods are shown in Table 2. Lowest values were obtained for all internal egg quality traits at week 7, except for albumen height. Mean values for albumen height increased from week 7, reached its peak at week 10 and declined to give the lowest value at week 13.

Table 3. Variance Components and Repeatability Estimates for External Egg Quality Traits of Japanese Quail

Parameter/Egg Quality Trait	V _I	V _e	R	n	se
EWT	0.428	0.1322	0.764013	25	-
EW	0.000525	0.01318	0.038307	25	0.064487
EL	0.001292	0.01353	0.087168	25	0.064102
SWT	0.000034	0.01607	0.002111	25	0.06455
ST	1.17E-06	6.79E-06	0.14663	25	0.062779

EWT = Egg Weight (g); EW = Egg width (mm); EL = Egg Length (cm); SWT = Shell Weight (g); ST = Shell Thickness (mm)

V_I = Individual variance component; V_e = Error variance component; R = Repeatability estimate; n = Number of observation; se = Standard error; - = Inestimable

Table 4. Variance Components and Repeatability Estimates for Internal Egg Quality Traits of Japanese Quail

Parameter/Egg Quality Trait	V _I	V _e	R	n	se
YH	-	-	-	25	-
YD	-	-	Ne	25	-
YWT	0.004296	0.1453	0.028717	25	0.064517
AH	-	-	Ne	25	-
AD	0.000182	0.208	0.008274	25	0.06455
AWT	0.005379	0.09879	0.051637	25	0.064424

YH = Yolk Height; YD = Yolk Diameter; YWT = Yolk Weight; AH = Albumen Height; AD = Albumen Diameter; AWT = Albumen Weight V_I = Individual variance component; V_e = Error variance component; R = Repeatability estimate; n = Number of observation; se = Standard error; - = Inestimable; ne = inestimable

Repeatability Estimates of External Egg Quality Traits in Japanese Quail

Repeatability estimates of external egg traits of Japanese quail at weeks 7, 8, 9, 10, 11, 12 and 13 are presented in Table 3. Repeatability estimate was high (0.76) for only Egg weight (EWT). This is an indication of strong genetic contribution on egg weight. Repeatability estimates for egg weight, egg length, shell weight and shell thickness were very low. Repeatability estimates for external egg quality traits in the present study were observed in the following order: 0.764 (EWT),

0.147 (SS), 0.087 (EL), 0.038 (EW) and 0.002 (SWT).

Repeatability Estimates of Internal Egg Quality Traits in Japanese Quail

Repeatability estimates of internal egg traits of quail at weeks 7, 8, 9, 10, 11, 12 and 13 are presented in Table 4. Repeatability estimates for yolk weight (0.029), albumen diameter (0.008) and albumen weight (0.052) were very low.

Discussion

External Egg Quality Traits in Japanese Quail

Generally, the values varied with age. These results agree with the work of [7] with local chickens, particularly because the mean of shell thickness throughout the experimental period was not significantly different ($P>0.05$).

Internal Egg Quality Traits in Japanese Quail

On the whole, values varied with age. Results in the present study were similar to those earlier reported [10, 11]. Results obtained from the analysis of variance applied on the measured parameters showed significant differences ($P<0.05$) between weeks for internal egg quality traits. Values for all internal egg quality traits did not indicate increase with age. Similar results had been reported by [12].

Repeatability Estimates of External Egg Quality Traits in Japanese Quail

Repeatability estimates for egg weight ranging from 0.57 to 0.78 had been reported by [13]; [14] for birds of different ages and genetic backgrounds of chickens and layers. These are in agreement with the findings of [15, 8, 16 and 17]. Similar opinion had been expressed by [18] who established that egg weight is a key parameter in determining most of the external egg quality traits of quail eggs and may even serve as an indicator of possible changes that could have occurred in the internal egg quality traits of the eggs. Results of the present study agree with the low estimates obtained by [19] and [20]. The low estimates, according to [17], could be attributed to environmental influence and age related factors, among other factors. Low repeatability estimates obtained for some external egg quality traits in this study reveal the need for an improvement.

Repeatability Estimates of Internal Egg Quality Traits in Japanese Quail

These low estimates are indicative of strong environmental influence on the traits. Repeatability estimates for yolk diameter, yolk height and albumen height were inestimable because of negative variance components. Negative variance components could be as a result of small data size or the negligible contribution of additive variance component. The number of observations used for estimation in this study was twenty-five (25).

Conclusion and Applications

1. Only egg weight would require a maximum of 7 records to adequately characterize the inherent ability of each Japanese quail hen due to its estimated high repeatability of 0.76. More records would be needed to achieve this for the other external and internal egg quality traits.
2. Selection for improvement using egg weight with its high repeatability estimate will result in good performance and significant genetic gain throughout the period of egg production.
3. Egg weight should be adopted as the key determinant for repeatability estimations in Japanese quail since fewer records would be required to adequately characterize the inherent producing ability of the birds.

References

1. Baumgartner, J. (1993). Japanese quail production, breeding and genetics. *World's Poultry Science Journal*. 50:227 – 235.
2. Kayang, B. B., A.Vignal, M. Inone-Murayama, M. Miwa, J. L. Monvoisin, S. Ito and F. Minvielle (2004). A first generation micro satellite linkage map of the Japanese quail. *Animal Genetics*. 35:195 – 200.

3. Muthukumar, S. P. and A. K. Dev-Roy (2005). Alternate Poultry Production in India – an overview. Delhi. Sadana Publishers and Distributors. Pp. 19 – 35.
4. Dauda, G., O. M. Momoh, N. I. Dim and D. M. Ogah (2014). Growth, Production and Reproductive Performance of Japanese quail (*Cortunix coturnix japonica*) in humid environment. *Egyptian Poultry Science Journal*. 43(2):381 – 395.
5. McDaniel, G. R., D. A. Roland and M. A. Coleman (1978). The effect of shell egg quality on hatchability and embryonic mortality. *Journal of Poultry Science*. 58:10 – 13.
6. Silversides, F. G. and T. A. Scott (2001). Effect of storage and layer age on quality of eggs from two lines of hens. *Poultry Science Journal*. 80:1240 – 1245.
7. Udoh, U. H., B. Okon and A. P. Udoh (2012). Egg quality characteristics, phenotypic correlations and prediction of egg weight in three (naked neck, frizzled feather and normal feathered) Nigerian local chickens. *International Journal of Poultry Science*. 11(11):696 – 699.
8. Akpa, G. N., J. Kaye, I. A. Adeyinka and M. Kabir (2008). The relationships between laying age and repeatability of egg quality traits in Japanese quails. *International Journal of Poultry Science*. 7(6):555 – 559.
9. NIMET (2011). Annual Rainfall predictions. National meteorological Agency, Abuja, Nigeria. Pp. 6 – 15, 19 – 20.
10. Nazligul, A., K. Turkyilmaz and H. E. Bardakcioglu (2001). A study on some production traits and egg quality characteristics of Japanese quail. *Archiv fur Geflugelkunde*. 68:280 – 283.
11. Kul, S. and I. Seker (2004). Phenotypic correlation between external and internal egg quality traits. *International Journal of Poultry Science*. 3:400 – 405.
12. Curtis, P. A., F. A. Gardner and D. B. Mellor (1985). A comparison of selected quality and compositional characteristics of brown and white shell eggs. *Poultry Science*. 64:302- 306.
13. Ibe, S. N. (1984). Repeatability of egg quality traits in white Leghorn chickens. *Nigerian Journal of genetics*. 5:44 – 49.
14. Ayorinde, K. L. and C. Sado (1988). Repeatability of egg weight and egg shape of an exotic commercial layer in Nigeria. *Nigerian Journal of Animal Production*. 15:157-160.
15. Okonkwo, J. C. and S. N. Ibe (1994). Repeatability of egg number and egg quality traits in commercial pullets. *Nigerian Journal of Animal Production*. 21:71 – 75.
16. Udeh, I. (2010). Repeatability of egg number and egg weight in two strains of layer type chicken. *International Journal of Poultry Science*. 9(7):675 – 677.
17. Amao SR, LO Ojedapo and RI Ogundipe(2013). Repeatability estimates of egg quality traits in pharaoh quail (*cortunix coturnix japonica*) reared in Derived Savannah. *Journal of Agriculture and Biosciences*. 2 (4):156 – 159.
19. Bennerwitz, J. O., O. Morgades, R. Preisinger, G. Thaler and E. Kalm (2007). Variance components and breeding value estimation for reproductive traits in laying hens using a Bayesian threshold model. *Poultry Science*. 86:823 – 828.
18. Ojedapo, L. O. (2013). Evaluation of body weight and other linear body

- parameters of Marshall broiler for repeatability estimates. *International Journal for Agricultural and Apicultural Research*. 9 (1 and 2): 175 – 181.
20. Ojedapo, L. O., T. A. Adedeji, T. B. Olayeni, S. O. Adedeji, A. R. Abdullah and O. O. Ojebiyi (2007). Influence of age and sex on body weight and some linear measurements of extensively reared WAD goats in derived savannah zone of Nigeria. *Journal of Animal and Veterinary Advances*. 6:114 – 117.