International Journal of Horticulture and Agriculture Research

ISSN(print): 3117-3063, ISSN(online): 3117-3071

Volume 01 Issue 03 December 2025

Page No: 60-64

Repeating-Ability Potentials of Japanese Quail for Egg Quality Characteristics in Borno State, Nigeria

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ABSTRACT: The research was conducted at the University of Maiduguri Livestock Teaching and Research Farm, Borno state to estimate repeatability of egg quality traits in Japanese quails. Eighty Japanese quail chicks of wild-type (20 males and 60 females) were randomly caged with a mating ratio 1:3 and used as base population in a Nested design. A total of 1,320 eggs collected from 110 quail hens from offspring of the base population. The first two eggs laid by each bird at weeks 10, 12, 14, 16, 18 and 20 of age were used for the egg quality traits analysis. Variance components and repeatability were estimated using Restricted Maximum Likelihood (REML) procedures. Repeatability was generally high, suggesting that characterizing the inherent transmitting ability of individual quail hen would require a few records. The highest (0.79±0.03) estimate for external trait was recorded for egg surface area and shell weight per unit surface area at sixteen weeks of age. No regular pattern was observed in these estimates. Among the traits related with albumen, upper limit (0.81±0.03) was recorded for Albumen index at age 20, while traits related with yolk had highest (0.65±0.05) coefficient for yolk weight (YW) at age18. The study revealed the age at which maximum repeatability for egg quality traits in Japanese quail could be expected. As estimates of some albumen-related traits increased with laying age, those of yolk did not follow any regular pattern. The more repeatability estimate increased with age, the lower the gains when selection is made.

KEYWORDS: Estimates, variance components, Japanese quail, external quality traits, internal quality traits.

INTRODUCTION

Prior to characterization of avian and other species, reliable estimates of their respective genetic parameters are required (Adeoye et al., 2022). In classical breeding, two main tools for genetic improvement of farm animals are selection and mating systems (Abdullahi et al., 2022). However, certain genetic parameters must be determined in order to employ these tools. The knowledge of genetic parameters enables the breeder to decide on the best method of selection that will achieve rapid genetic progress. Genetic parameters such as heritability, repeatability and correlations, are gaining upper hand in Nigeria as tools for determining appropriate evaluation for farm animal improvement (Wolc et al., 2007, Toye et al., 2012, Abe et al., 2024). In addition to heritability and genetic correlation of traits, repeatability is another useful parameter estimate, providing a tool for quantifying the transmitting potential of a stock and its ability to maintain its performance and ranking within a test group on subsequent performance (Udeh, 2010).

Dohm (2002) described repeatability as a term used to depict the extent of an individual's consistency in performance or behaviour over a period of time. In other words, repeatability is a measure of repeating ability of an individual either in production or behavioural potentials. Currently in Nigeria, estimation of various genetic parameters especially repeatability and heritability are given priority in determining the appropriate animal evaluation (Toye et al., 2012). Repeatability is regarded as a tool used to estimate the over-time extent of consistent performance or behaviour of an individual (Eshimutu et al., 2022). When a trait or group of traits has moderate to high repeatability, the implication is that great reliability can be put on selection or culling of individuals for that trait, based on a few records (Kabir, 2010). It should be noted that success of any selection for improvement does not only lies on the ability to reliably predict present and future performance of an animal but also on the transmitting capacity of its potentials to its offspring. It is therefore pertinent to gear efforts towards defining the means to achieve best maximal value for both their repeating- and heritable- potentials (Abdulraheem et al., 2022).

An egg is both a reproduction tool and a nutritious food source for man (Tyasi et al., 2022). The characteristic quality of egg can be described as external and internal qualities. While the external quality lies on texture, colour, shape, soundness and cleanliness of egg, the internal quality trait lies on the functional, aesthetic and microbiological properties of egg yolk and albumen. Although, it's on record that substantial studies have been carried out on egg quality traits in other Galliformes, a few of such was available on

Japanese quails from this part of the country, northeast Nigeria. The intent of this study was therefore to assess the repeating-ability potentials of Japanese quail reared in Maiduguri, northeast Nigeria, for external and internal egg quality traits.

MATERIALS AND METHODS

The research was conducted at the University of Maiduguri Livestock Teaching and Research Farm, Maiduguri, Borno state. The state by geography falls within the Northeast Geo-political zone of Nigeria. Maiduguri, the Borno state capital is located on Latitude 11^0 5', and Longitude 13^0 09' E (Encarta, 2007) and on altitude 354 m above sea level in the Northeastern Nigeria. Based on the atmospheric condition of the area, the seasons are divided into three: dry hot (February to May), dry cold (October to January) and wet (June to September), and the vegetation zone is Sahelian type. The dry season lasts for eight to nine months with the hottest period occurring between March and June when the ambient temperatures are in the range of $35^0 – 44^0$ C which are highest by the months of April and May. The relative humidity of Maiduguri is 17.28% for dry hot season, 53.03% during the wet season and 2.05% for the dry cold season (World Weather API and Weather Forecast, 2024).

EXPERIMENTAL MATERIALS

Eighty (80) four weeks old Japanese quail chicks of wild-type strain (20 males and 60 females) were purchased from National Veterinary Research Institute, Vom, Plateau state, Nigeria which served as the base population. A total of three hundred (300) eggs were collected from the base population and set for hatching in a forced air incubator (1510 Sportsman Cabinet incubator GQF Manufacturing Company, USA). Eggs from the resulting progeny were used for egg quality analysis.

MANAGEMENT OF EXPERIMENTAL BIRDS

Quail chicks were raised in quail brooder till four weeks of age. sexing was done at 3 weeks of age as the females can be distinguished from the males by their characteristic light feathers with black speckling on the throat and upper breast (Randal and Bolla, 2008). Birds were randomly placed in cages in a mating ratio of 1:3. The dimension of the wire mesh cages is 40 x 30 x 30 cm. 12:12 light: dark cycle was applied. The birds were allowed free access to feed and water. The quail were given quail diet containing 25% CP and 3000 Kcal ME/Kg in the first 6 weeks period and later reduced to 24% CP and 2750 Kcal ME/kg. constant sanitation of the pen including the feeder was carried out. Notwithstanding their hardy nature, antibiotics were given at regular intervals as described by the manufacturer for preventive measure against poultry diseases. The research lasted for ten months.

DATA COLLECTION

A total of 1.320 eggs were collected from 110 quail hens (offspring of the base population) at 80% hen day egg production between August and October. The first two eggs laid by each bird at weeks 10, 12, 14, 16, 18 and 20 of age were used for the egg quality traits analysis.

The egg weight was taken using a 0.01 g sensitive electronic scale. Egg height and width were measured using a vernier calipers. Thereafter, the internal components of egg were obtained by carefully breaking the egg around the narrow end and the components were received on a table with glass cover. The measurements of yolk height, yolk diameter, albumen length, width and height were taken using a vernier calipers. After these measurements, the yolk was carefully separated from the albumen by punching the albumen then the yolk weight was measured with the scale.

The egg shell (when the egg had been emptied of its internal components) was carefully washed with water to remove the remnant of albumen and was thereafter air-dried for 24 hours. This was then weighed using an electronic scale (0.01 g sensitive). Samples taken from sharp, blunt and equatorial parts were measured using 0.01 mm sensitive micrometer screw gauge and the average of the parts was taken as average shell thickness. Other traits were computed as follows

according to Kul and Seker (2004):

$S= 3.9782\ W^{0.75056}$

Where S= egg surface area (cm^2), W=egg weight (g);

Shell weight per unit surface area (mg/cm^2) = shell weight (mg)/ egg surface area (cm^2)

Shell ratio (%) = shell weight (g) / egg weight (g) x 100

Shape index (%) = (egg width (cm)/egg height (cm) x 100)

Albumen index (%)= albumen height (mm)/ (albumen length (mm)+ albumen width(mm)/2 x 100)

Albumen ratio (%)= albumen weight (g) / egg weight (g) x 100

Yolk index (%) = yolk height (cm)/yolk diameter (cm) x 100

Yolk ratio (%) = (yolk weight (g) / egg weight (g)) x 100

Albumen weight (g) = egg weight (g) – (yolk weight (g) + shell weight (g))

Haugh unit (%) = $100 \log (H + 7.57 – 1.7W0.^{37})$

Where H = albumen height (mm), W= egg weight (g)

DATA ANALYSIS

Variance and genetic parameters were estimated using Restricted Maximum Likelihood (REML) procedures software (Harvey, 1990). The repeatability of the egg quality traits was estimated using the following expression:

$$R = \frac{\sigma^2{}_w}{\sigma^2{}_w - \sigma^2{}_e}$$

Where R = repeatability,

$\sigma^2{}_w$ = variation between individuals

$\sigma^2{}_e$ = variation between measurements within individuals

The repeatability Standard error was approximated following the expression of Becker (1985):

$$S.E.\ (R) = \frac{\sqrt{(1-R)^2\{1+(K-1)R\}^2}}{K(K-1)(N-1}$$

Where $S.E.\ (R)$ = standard error of repeatability

K = number of measurements taken on each individual

N= number of individuals

RESULTS AND DISCUSSION

Repeatability estimates of external egg quality traits are shown in Table 1. The highest estimate (0.79±0.03) was recorded for both egg surface area and shell weight per unit surface area at sixteen weeks of age. The lowest (0.12 ±0.09) coefficient on the other hand was observed at ten weeks of age for egg height. This signifies the age at which repeatability in the external quality traits of quail egg is maximum. By implication, it is at this maximum repeatability age that the prediction of most probable transmitting potentials of individual quails for the examined traits for selection purpose is best done (Akpan et al., 2008). The repeatability estimates of external egg quality characteristics were generally high. Meanwhile, high repeatability values suggest that a few records would be required to characterize the inherent transmitting potential of individual quail hen. The estimates over the ages followed no regular pattern for external egg quality traits.

The repeatability estimate of 0.54 obtained for egg weight in the current study at the age of sixteen weeks is similar to 0.57 earlier reported by Ingram et al. (1989) in Bob white quail. The value reported in this study is however lower than 0.77 obtained by Akpan et al. (2006) in Japanese quail falling in the range 0.75 to 0.85from 12 to 28 weeks of age. In a similar manner, the estimate of 0.61 obtained for shell weight in this study is not far from 0.68 recorded by Akpan et al. (2006) at 12 weeks. Although, this was lower than 0.98 earlier reported by these authors. The variations in the results revealed the differences in the age, genetic constitution of the quail hens and difference in climates to which the studies were carried out.

Similar to the co-efficients for the external egg quality traits (Table 1), the estimates for internal egg quality parameters (Table 2) are generally high. The highest (0.81±0.03) repeatability was identified with albumen index while the lowest (0.14±0.09) was recorded for yolk diameter both at 20th week of age. Among the traits related with albumen, the upper limit (0.81±0.03) was recorded for albumen index while the lowest (0.17±0.08) was recorded for albumen ratio both at age 20. For the traits related with yolk on the other hand, highest value (0.65±0.05) was obtained for yolk weight at 18th week of age. This result revealed the age at which maximum repeatability for internal egg quality traits in Japanese quail could be expected (within the age range considered). The result also suggests that this will be the best age for predicting most probable transmitting ability for the internal traits of quail hens. Repeatability estimate of 0.51 for albumen height recorded in this study is higher than 0.06, 0.11 and 0.15 earlier reported by Ingram et al. (1989) in Bobwhite quail. Meanwhile, higher values of 0.95 and 0.99 were reported by Akpan et al. (2006) at twelve and twenty weeks of age. These authors as well reported an estimate of 0.77 for egg width which is not far from 0.72 observed in the current investigation at twelve weeks in Japanese quail. The value is however lower than 0.84 observed by Akpan et al. (2008) at 28 weeks of age. The variation is not unexpected because the age range considered in this study varies from that of other authors. Thus, difference in age intervals considered may be the rationale for the variations. Repeatability of 0.76 recorded for albumen width by Akpan et al. (2006) at 12 week is similar to 0.72 obtained in this study but the estimate is lower than 0.83 recorded by the same authors at 28 weeks both in Japanese quail. The study also revealed discrepancies in the estimates of repeatability, and those recorded in literatures. According to Akpan et al. (2008), this might be a reflection of the differences in ages of birds used, and the various environmental factors affecting the experimental animals.

Generally high repeatability estimates obtained in this study is associated with some advantages: less record will be required to characterize the inherent transmitting ability of individuals; it saves cost of collecting more data (Ibrahim, 2004); and minimizes the time of collecting additional data (Akpan et al., 2008). While some estimates recorded for albumen-related traits were seen to increase as laying age progressed, estimates recorded for yolk-related traits did not follow any regular pattern. For instance, estimates of traits like albumen height, index and Haugh unit among others increased with increased laying age. Increased repeatability estimate with advanced age could be regarded as an indication of progressive maternal influence on these traits with advanced age (Akpan et al., 2008). By implication, the higher the repeatability, the lower the gain when selection is made.

Table 1: Repeatability estimates (R) of external egg quality characteristics of Japanese quail at different ages

Age (week)	EW	EH	EW	SW	AVGST	SR	ESA	ESI	SWUS
10	0.52±0.07	0.12±0.09	0.28±0.08	0.42±0.08	NA	0.35±0.08	0.51±0.08	0.35±0.08	0.50±0.07
12	0.53±0.07	0.74±0.04	0.42±0.08	0.56±0.06	0.34±0.08	0.25±0.09	0.78±0.04	NA	0.76±0.04
14	0.52±0.07	0.62±0.06	0.72±0.04	0.61±0.06	0.59±0.06	0.40±0.08	0.78±0.04	0.58±0.06	0.76±0.04
16	0.54±0.07	0.69±0.05	0.28±0.08	0.62±0.06	0.54±0.07	0.50±0.07	0.79±0.03	0.57±0.06	0.79±0.05
18	0.35±0.08	0.75±0.05	0.51±0.07	0.58±0.06	0.73±0.04	0.42±0.08	0.74±0.04	0.57±0.06	0.71±0.05
20	0.38±0.08	0.54±0.06	0.26±0.08	0.43±0.08	0.55±0.06	0.17±0.09	0.64±0.05	0.37±0.08	0.65±0.05

NA=not available

Table 2: Repeatability estimates (R) of internal egg quality characteristics of Japanese quail at different ages

Age (weeks)	AL	AH	WA	AW	YH	YD	YW	AR	YI	YR	HU	AI
10	0.34±0.08	0.27±0.08	0.42±0.08	0.45±0.07	0.33±0.08	0.24±0.09	0.37±0.08	0.34±0.08	0.24±0.09	0.31±0.08	0.25±0.09	0.22±0.09
12	0.42±0.08	0.28±0.08	0.45±0.07	0.63±0.06	0.46±0.07	0.34±0.08	0.58±0.06	0.35±0.08	0.31±0.08	0.31±0.08	0.28±0.08	0.43±0.09
14	0.67±0.06	0.43±0.08	0.72±0.04	0.60±0.06	0.61±0.06	0.54±0.06	0.50±0.07	0.21±0.09	0.49±0.07	0.18±0.09	0.36±0.08	0.53±0.07
16	0.64±0.05	0.51±0.06	0.62±0.06	0.63±0.06	0.63±0.06	0.37±0.08	0.61±0.06	0.26±0.09	0.53±0.07	0.28±0.08	0.48±0.08	0.49±0.07
18	0.71±0.05	0.57±0.06	0.65±0.05	0.54±0.06	0.54±0.06	0.42±0.08	0.65±0.05	0.25±0.09	0.48±0.07	0.26±0.09	0.52±0.07	0.63±0.06
20	0.79±0.03	0.47±0.07	0.35±0.08	0.29±0.08	0.36±0.08	0.14±0.09	0.57±0.06	0.17±0.09	0.26±0.09	0.21±0.09	0.43±0.08	0.81±0.02

CONCLUSION

Repeatability estimates were generally high for egg quality traits in Japanese quails which indicates that a few records would be required to characterize the inherent transmitting ability of individual quail hen. The study revealed the age at which maximum repeatability for external and internal egg quality traits in Japanese quail could be expected. No regular pattern was observed in the pattern of external egg quality estimates over ages. Repeatability estimates for albumen-related traits showed maternal influence as laying progressed.

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