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HERITABILITY AND REPEATABILITY ESTIMATES OF EGG QUALITY TRAITS IN JAPANESE QUAILS RAISED IN NORTHEASTERN NIGERIA

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Abstract
Heritability and repeatability were estimated for egg quality traits in Japanese quails reared in Maiduguri, Northeast Nigeria using Restricted Maximum Likelihood (REML) Procedures. The egg quality traits examined were: egg weight (g), egg height (cm), egg width (cm), shell weight (%), shell ratio (%), shell weight per unit surface area (mg/cm^2), Haugh unit (%), albumen weight (%), albumen ratio (%), yolk index, yolk diameter (cm) and yolk weight (%). Heritability of external egg traits ranged moderate to high (0.33 - 0.81) at 10 and 20 weeks old. High estimates indicate low maternal influence on the traits. Egg traits were highly heritable at early laying age (10 weeks) than later age (20 weeks), a suggestion for early selection. Egg size traits (EW, EH, WE) were generally highly heritable than egg shell traits (SW, SR, SWUS) indicating effect of environmental factors on egg shell traits. Estimates of albumen weight, yolk index and yolk diameter were higher at week 20 than at week 10. In general, albumen related traits (Hu, AW, AR) were highly heritable than those of yolk (YI, YD, YW), an indication that albumen may be better improved than yolk. Repeatability estimates ranged low to high (0.12 – 0.65). High estimate suggested that fewer records will be required to characterize the inherent transmitting ability of individual quail. Young laying quails were highly repeatable for albumen related traits while the old laying quails were highly repeatable for yolk related traits implying that prediction of most probable transmitting ability for albumen traits would be best done at early period.
Key words: Heritability, Repeatability, Japanese quail, Egg quality traits, Northeast

Introduction
Poultry production is an integral part of Nigerian economy especially within the last two decades (Raji *et al.*, 2015). This is because meat and eggs production has witnessed tremendous increase (Alimi *et al.*, 2006) over the years. The performance of poultry is partly determined by genotype which is transmissible and by environmental factors that must be controlled in a way that would give maximum expression of genetic potentials of these farm animal species (Toye *et al.*, 2012). In the context of any specific environment, the degree of genetic improvement from selection in a flock depends largely on the character under consideration and its repeating (repeatability) and heritable abilities (heritability) among other factors (Toye *et al.*, 2012). In other words, success of selection relies on the ability to reliably predict present and future performance of an animal as well as its transmitting capacity of its potentials to its offspring. Therefore, efforts must be geared towards defining means through which a maximal value is best attained for both their repeatability and heritability. In Nigeria, genetic parameters such as heritability and repeatability are given priority in the determination of appropriate evaluation of breeding value of individual farm animal (Wole *et al.*, 2007). Although, it's on record that substantial studies have been carried out on genetic parameters of egg quality traits in other galliforms and quails, a few of such was available on Japanese quails from this part of the country. The intent of this work therefore was to estimate heritability and repeatability of egg quality traits in Japanese quails reared in Maiduguri, Northeast Nigeria using Restricted Maximum Likelihood Procedures.

Materials and Methods
Experimental location
The research was conducted at the University of Maiduguri Livestock Teaching and Research Farm, Maiduguri, Borno State, Northeast Nigeria. Maiduguri, the Borno State capital is located on the latitude 11^0 5' N, and longitude 30^0 09' E (Encarta, 2007) and on the altitude of 354 m above sea level in the Sahel region.

The seasons comprise dry hot (February to May), wet (June to September) and dry cold (October to January). The dry season lasts for eight months with the hottest period occurring between March and June when the ambient temperatures are in the range of 35 - 40^0 C which are highest by the months of April and May. The relative humidity ranges from 45 – 50% (Kellou, 2005) with a minimum in February and March when it drops to as low as 10% and a maximum of 90% in August. The Annual rainfall ranges from 150-600 mm.

Experimental birds and management

Eighty 4 weeks old Japanese quail chicks (20 males and 60 females) were purchased from National Research Institute Farm in Vom, Plateau State, Nigeria (base population). 300 eggs were collected from the base population and set for hatching in a forced air incubator. Quail chicks were raised in quail brooder till four weeks of age. Meanwhile, sexing was done at about 3 weeks of age. Birds were randomly placed in cages in a mating ratio of 1:3. The dimension of the wire mesh cages is 40 x 30 x30 cm. 12:12 light: dark cycle was applied. They were given food and water *ad libitum*. They were given quail diet containing 25% CP and 3000 KCalME/Kg. Constant sanitation of pen including the feeders was carried out.

Data collection

A total of 1,320 eggs were collected from 110 quail hens, offspring of the base population from 10 to 20 weeks of age and were used for 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 caliper. The measurements of yolk diameter were taken using a vernier caliper. Yolk weight was measured with the scale. Egg shell was air dried for 24 hrs and weighed. The following formulae were adopted according to Kul and Seker (2004) for other traits:

S= 3.9782 $W^{0.75056}$ Where S= egg surface area (cm^2), W= egg weight (mg)

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

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

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

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

Haugh unit = 100 log ($H+7.57-1.7W^{0.37}$) Where H= albumen height (mm), W=egg weight (g)

Data analysis

Variance and covariance components and genetic parameters were estimated using Restricted Maximum Likelihood (REML) Procedures software (Harvey, 1990).

$h^2{}_s = \frac{4\sigma^2{}_s}{\sigma^2{}_s + \sigma^2{}_d + \sigma^2{}_w}$ Where $h^2{}_s$ = heritability from sire variance component, $\sigma^2{}_s$ = variance component for sire, $\sigma^2{}_d$ = variance component for dam, σ^2w= error variance component, Standard error (S.E.) for heritability estimates were approximated following the method of Dickson (1969):

$$S.E.(h^2{}_s) = \frac{\sqrt{\frac{2}{k^2{}_3} + \frac{ms^2{}_s}{s-1} + \frac{ms^2{}_d}{d-s}}}{4\sigma^2{}_T}$$

Where: $ms^2{}_s$ = mean squares of sire, $ms^2{}_d$ = mean squares of dam, $\sigma^2{}_T$ = total variance, d= number of dams, s= number of sire

Repeatability of egg quality traits were estimated using the following expression according to Okonkwo and Ibe (1994): $R = \frac{\sigma^2{}_w}{\sigma^2{}_w + \sigma^2{}_e}$ Where R = repeatability, $\sigma^2{}_w$ = variation between individuals, $\sigma^2{}_e$ = variation between measurements within individuals, The expression of Becker (1985) was used to generate standard error for repeatability:

$S.E.(R) = \frac{\sqrt{(1-R)^2[1+(K-1)R]^2}}{K(K-1)(N-1)}$ Where K = number of measurement on individual, N= number of individuals

S.E. (R) = standard error of estimated repeatability of a trait

Results and Discussion

Heritability estimates of external egg quality traits of Japanese quails at 10 and 20 weeks of age range moderate to high (Table 1). At 10 weeks of age, the highest (0.60) value was observed for shell weight per unit surface area (SWUS) while the lowest (0.36) was observed for egg height (EH). At 20 weeks of age, the

heritability estimate of external egg traits was highest (0.81) for egg width (WE) and lowest (0.33) for egg weight (EW). The values were within the range (0.08-0.83) observed by Sezer (2007) in Japanese quail. However, they were higher than the range (0.19-0.38) reported for egg weight by Ingram *et al.* (1989) in Bobwhite quail. High heritability estimate (0.51) for egg weight reported in this study is similar to the value (0.57) reported by Suleiman *et al* (2021) in Shika Brown chickens. In general, egg traits were highly heritable at the early laying period (10 weeks) than at the later period (20 weeks). Heritability values for egg size traits (EW, EH, WE) were generally higher than the values for egg shell traits (SW, SR, SWUS), possibility of egg size traits to respond better to selection for improvement. Repeatability estimates for the eternal egg quality traits ranged low to high (0.12 – 0.65). At 10 week, the highest (0.52) co-efficient was obtained for EW while the lowest (0.12) was observed for EH. SWUS had the highest (0.65) repeatability value while shell ratio (SR) had the least (0.17) at 20 weeks of age. This is in line with Suleiman *et al* (2021). Repeatability estimates of external egg traits at the early laying period were higher for EW, WE and SR while at the later laying period, EH, SW and SWUS had higher repeatability values. This is however contrary to the report of Akpa *et al* (2006). This report implies that it is at this maximum repeatability age that the prediction of most probable transmitting ability of individuals for traits considered for selection purpose is best done (Akpa *et al.*, 2008). Table 2 presents the results of heritability and repeatability of internal egg quality traits in Japanese quails at 10 and 20 weeks of age. Similar to the values observed for external traits, the heritability estimates ranged moderate to high. This implies that selection made on such trait at the particular age would yield optimum improvement. The highest value (0.96) was observed for Haugh unit (Hu) and the lowest (0.18) for Yolk index (YI) at the early laying period (10 week). On the other hand, albumen ratio (AR) had the highest (0.98) heritability and yolk weight (YW) had the least (0.40) at 20 week. Heritability estimates of albumen weight (AW), YI and yolk diameter (YD) were higher at week 20 than at week 10. Conversely, estimate of YW was higher at week 10. In general, albumen related traits (Hu, AW, AR) were highly heritable than those of yolk related traits (YI, YD, YW), implies albumen traits to be better improved.

Table 1: Heritability and repeatability estimates of external egg quality traits in Japanese quails at 10 and 20 weeks of age

	Heritability		Repeatability	
Trait	**Week 10**	**Week 20**	**Week 10**	**Week 20**
Egg weight	0.51±0.30	0.33±0.24	0.52±0.07	0.38±0.08
Egg height	0.36±0.21	0.91±0.31	0.12±0.09	0.54±0.06
Egg width	0.89±0.31	0.81±0.31	0.28±0.08	0.26±0.09
Shell weight	0.46±0.21	0.42±0.23	0.42±0.08	0.43±0.08
Shell ratio	1.07±0.33	0.69±0.28	0.35±0.08	0.17±0.09
Shell weight per unit surface area	0.66±0.26	0.49±0.24	0.50±0.07	0.65±0.05

Table 2: Heritability and repeatability estimates of internal egg quality traits in Japanese quails at 10 and 20 weeks of age

	Heritability		Repeatability	
Trait	**Week 10**	**Week 20**	**Week 10**	**Week 20**
Haugh unit	0.96±0.32	1.69±0.37	0.25±0.09	0.43±0.08
Albumen weight	0.92±0.31	0.97±0.32	0.45±0.07	0.29±0.08
Albumen ratio	1.20±0.35	0.98±0.32	0.34±0.08	0.17±0.08
Yolk index	0.18±0.17	0.77±0.29	0.24±0.09	0.26±0.09
Yolk diameter	0.47±0.24	0.60±0.26	0.24±0.09	0.14±0.09
Yolk weight	0.88±0.31	0.40±0.22	0.37±0.08	0.57±0.06

Repeatability estimates of AW and AR were higher at week 10 than at week 20 while the reverse was the case with YI and YW. Sooneharenying and Edwards (1989) reported repeatability estimates of 0.80 for egg weight and 0.98 for shell weight which were higher than the estimates observed in this study. The discrepancies in these estimates could reflect variations in ages of birds and environmental factors (Akpa *et al.*, 2006). Yolk traits that increased with laying age indicates progressive maternal influence with advanced age (Akpa *et al.*, 2008).

Conclusion

Heritability estimates of external and internal egg quality traits in Japanese quails at early and later laying ages were ranged moderate to high while the repeatabilities ranged low to high. Egg traits were highly heritable in the young laying quails than the old laying. Heritability values for egg size traits were generally higher than those of egg shell traits. Albumen related traits were highly heritable than yolk's. EW, WE and SR were highly repeatable in young laying quails and reverse was for EH, SW and SWUS in the old laying quails.

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