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The Relationships Between Laying Age and Repeatability of Egg Quality Traits in Japanese Quails (*Coturnix coturnix japonica*)

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Abstract: Repeatability at 12, 16, 20, 24 and 28-weeks of age of egg weight, egg length, yolk weight, albumen weight, shell thickness, shell membrane thickness, albumen index, yolk index, egg index and shape index was estimated based on the first three eggs laid in the week by forty-eight Japanese quail (*Coturnix coturnix japonica)* pullets. The estimated repeatability for these traits was high (0.58 - 0.99) with a consistent increase in repeatability as laying age progressed. Repeatability of egg length, egg index and shape index showed a linear relationship with age, where as the remaining traits showed a curvilinear relationship. The general increase in repeatability of each trait with age indicates that fewer records would be required to adequately characterize the inherent producing ability of each quail hen for the trait as laying age progressed. Maximum repeatability estimates were observed at 28 weeks of age.

Key words: Laying age, repeatability, associations, egg characteristics and quails

Introduction

Animal breeding prediction of breeding value of an individual is very important as it enables the breeder to determine the transmitting ability of each individual for desired economic traits. Early estimation of the most probable producing ability of each hen is of immense advantage from point of view of shortened generation interval and enhanced expected rate of annual genetic gain. Traits such as birth weight and slaughter weight can only be measured once during the lifetime of an animal, where as other traits like, body weight, egg traits, egg number can be measured at several periods.

There is dearth of information available in literature regarding repeatability of 28 weeks traits of quails. But similar studies in other commercial chicken pullets were reported by King and Hall (1955) who indicated varying repeatability coefficient values for egg quality traits at different seasons of the year and also noted a declining repeatability in the traits with increasing age in lay. Meritt *et al.* (1960), however, observed an increase in repeatability of same traits as laying period progressed. Decrease in maternal influence on egg characteristics as laying period progressed had been reported by Saadeh *et al*. (1968).

Wilhelmson (1975) reported repeatability estimates in egg traits of quails to be 0.46 to 0.58 while Sooncharenying and Edwards (1989) reported repeatability coefficient of 0.80 for egg weight, 0.98 for shell weight and 0.85 for shell thickness in quails. Other studies in commercial pullets showed repeatability coefficient of haugh unit and shell thickness ranging from 0.39 to 0.72 and from 0.17 to 0.45 (Goodman, 1965; Ibe, 1984). Repeatability estimates for egg weight, ranging from 0.57 to 0.78 had been reported by some other researchers for birds of difference ages and genetic background (Ayorinde and Sado, 1988; Goodman, 1965; Ibe, 1984) where as a range of 0.42 to 0.51 had been observed for the same traits by Farnsworth and Nordskog (1955). Goodman (1965) had reported a range of 0.35 to 0.68 for shape index. Wilhelmson (1975) and Sooncharenying and Edwards (1989) reported that all traits of quail egg had high repeatability estimate.

The objective of this study therefore, is to determine the relationships between age and repeatability of egg weight and egg quality traits and hence provide further information regarding the age at which repeatability of these traits could be estimated with maximum efficiency.

Materials and Methods

Location of the study: The study was conducted in Zaria, at the Poultry Unit of the Animal Science Department, Ahmadu Bello University, Samaru - Zaria.

According to Akpa *et al.* (2002), Zaria is within the Northern Guinea Savannah zone o Nigeria, latitude 11°12 N and longitude 7°33 E, at an altitude of 610m above sea level. The climate is relatively dry, with a mean annual rainfall of 700 - 1400mm, occurring between the months of April and September. The dry season begins around the middle of October, with dry cold weather that ends in February. This is followed by relatively hot, dry weather from March to sometime in April, when the rains begin. The mean minimum and maximum daily temperature is from about 14°C to 24°C during the cool season and from about 19°C to 36°C during the hot season. The relative humidity varies between 19% and 35% in the dry season and between 63% and 80% in the wet season.

Birds and their management: Forty eight (48) quail chicks of three (3) weeks old were purchased from the National Veterinary Research Institute Farm in Vom, Plateau state and reared in constructed cages of 0.30 x 0.61m^2/bird (30.48 x 60.96cm^2/bird or 1 x 2ft2 / bird). Regular water supply and *ad libitum* feeding using calculated feed analysis of energy 784.46Kcal/g ME and 28% CP for birds aged 3-5 weeks and there after the CP was reduced to 24.01%. The birds were brought in November, 2003 and the study lasted till May, 2004, giving a total period of 28 weeks.

Constant sanitation of the pen was carried out. Forty eight (48) rubber waterers were washed every morning and replaced back with clean cool water. The same process was carried out for the feeders and feeding. Observation of the birds, their medication and vaccination where carefully made for necessary measures against diseases, even though the birds hardly came down with any known disease. Their hardy condition not withstanding, antibiotics (neoterramycin) was given to the birds every two (2) moths as a preventive measure.

Data collection: Each egg collected was marked according to cage number and the productions were summarized on weekly and individual basis. A total of 4,827 eggs were produced by the 48 hen quails from the point when the population had 80% egg production (January to May, 2004). Egg collection was done twice daily at (9.00 and 4.00pm), respectively.

The first three eggs laid by each bird at week 12, 16, 20, 24 and 28 of age were used for the egg quality traits determination, by taken the weight of each egg, using Mettler PN 1210 (Max 1200g). Egg length was measured to the nearest 0.01mm using Vanier Caliper and the egg was broken on a known weight on a clean smooth paper that does not absorb liquid immediately (Glossary paper) and the yolk plus albumen weight was taken, while yolk weight was taken after gently separating it with hand from the albumen. The albumen weight was taken by subtracting yolk weight from the yolk plus albumen weight. The egg shell was collected and air dried for 1hour after which a micrometer screw gauge was used to determine the shall plus membrane thickness. There after the shell was separated from the membrane and shell thickness measured to the nearest 0.01mm. The shell membrane thickness was then determined by subtracting shell plus membrane thickness from shell thickness.

Each egg was examined for shape index as the ratio of width to length of an egg (Scheinberg *et al*., 1953). The shape indices were calculated (Chineke, 2001), using the formulae: maximum width/maximum length, such as for albumen index, yolk index, egg index and shape index.

Analytical procedure: The following mixed model was fitted to the data on each of the traits.

$$Y_{ijk} = \mu + G_i + I_{ij} + e_{ijk} \qquad (1)$$

Where Y_{ijk} is the K^{th} observation on the j^{th} individual within the i^{th} group, μ is the overall mean, G_i is the fixed effect of the i^{th} group, I_{ij} is the random effect of the j^{th} hen within the i^{th} group and the e_{ijk} is the random error.

Harvey's (1987) mixed model least squares and maximum likelihood programme was used to estimate the variance components required to estimate repeatability. Repeatability coefficient was estimated using the expression.

$$R = F_1^2 / (F_1^2 + F^2_e) \qquad (2)$$

Where F_1^2 is the variance component due to differences among individuals and estimates all the variances due to permanent portions of the record and F^2_e is the error variance component. Expression (3), due to Becker (1984), was used to estimate the standard error of the estimated repeatability coefficient.

$$S.E.(R) = \frac{2(1-R)^2 [1 + (K - 1)R]^2}{K(k-1)(n-1)} \qquad (3)$$

Where K is the number of records taken on each individual, n is the number of individuals and R is the estimated repeatability of a trait.

Both linear (4) and quadratic (5) models were fitted to the repeatability - age data for all traits to determine the actual relationship between the two.

$$Y_i = a + bX_i + e_i \qquad (4)$$

$$Y_i = a + b_1 x_i + b_2 Xi^2 + e_i \qquad (5)$$

Where Y_1 is the i^{th} repeatability estimate for a trait, a is the intercept, b_1 and b_2 are regression coefficients, X_i is the i^{th} age of individuals and e_i is the residual.

Results and Discussion

Table 1 shows the repeatability estimates of the measured characteristics. The repeatability estimates of these traits for 12, 16, 20 24 and 28 weeks were high, ranging from 0.54 to 0.99 with the exception of the shell membrane thickness at 12 weeks, which was 0.33.

Table 2 presents the comparative efficiency of linear and quadratic models in estimating the relationships between laying age and repeatability values of measured traits. The linear regression model was significant and efficiently (R^2 = 75-100%) estimated the relationship between laying age and the repeatability of

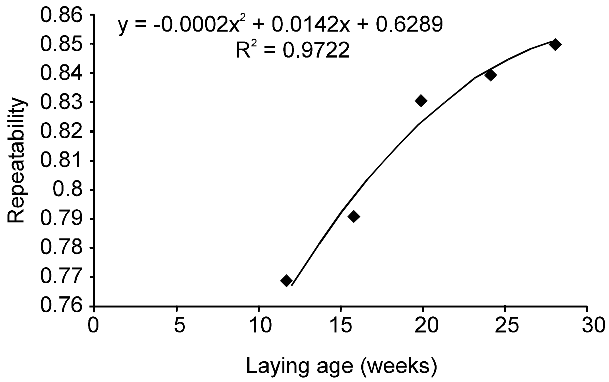

Fig 1: Relationship between repeatability of egg weight (g) and laying age (weeks).

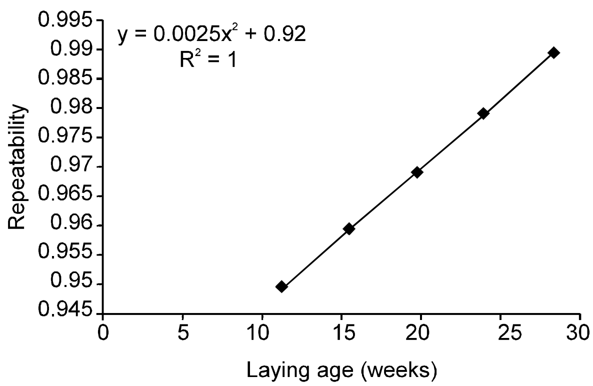

Fig. 2: Relationship between repeatability of egg length (mm) and laying age (weeks).

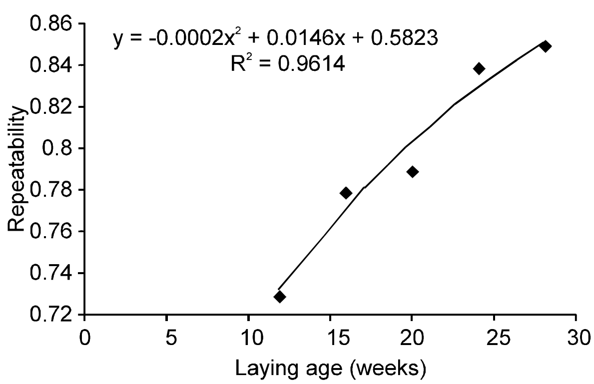

Fig. 3: Relationship between repeatability of yolk weight (g) and laying age (weeks)

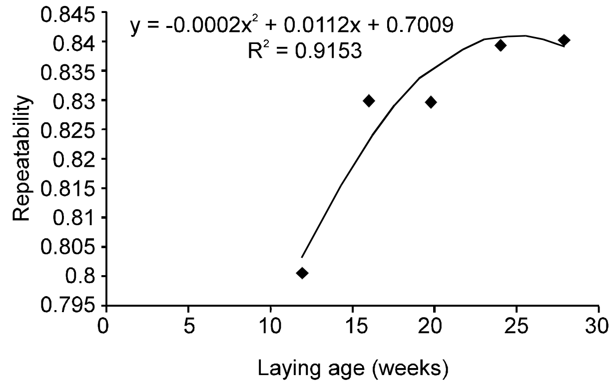

Fig. 4: Relationship between repeatability of albumen weight (g) and laying age .

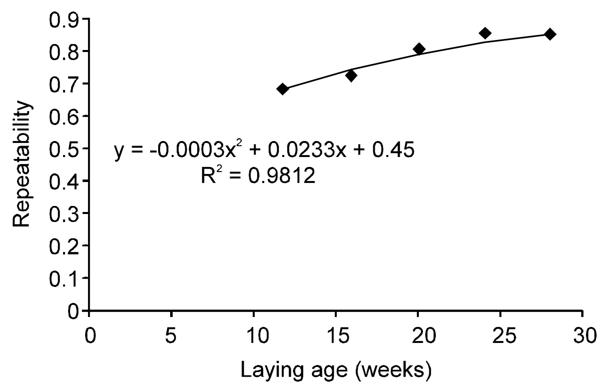

Fig. 5: Relationship between repeatability of Shell + membrane weight (g) and laying age (weeks).

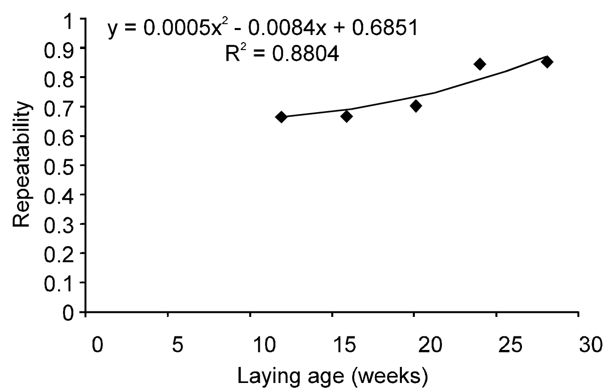

Fig. 6: Relationship between repeatability of shell thickness (mm) and laying age (weeks).

the measured traits, except for albumen index (R^2 = 50%). The quadratic model was better and significantly estimated the efficiency (R^2 = 86-100%) of relationships between laying age and repeatability of egg quality traits. The graphs of the better-fitted model of the regression of repeatability of egg quality traits on age of quail birds are presented in Fig. 1 to 10. Repeatability of egg length, egg index and shape index increased linearly with laying age. The rate of increase was 0.0025, 0.0065 and 0.0065 units per week, respectively. The rest of the relationships were quadratic in nature.

The high repeatability estimates ranging from 0.54 to 0.99 of the measured traits in this study agreed with the observation of Sooncharenying and Edwards (1989) with the exception of shell membrane thickness at 12 weeks, which was moderate (0.33). The implication of high

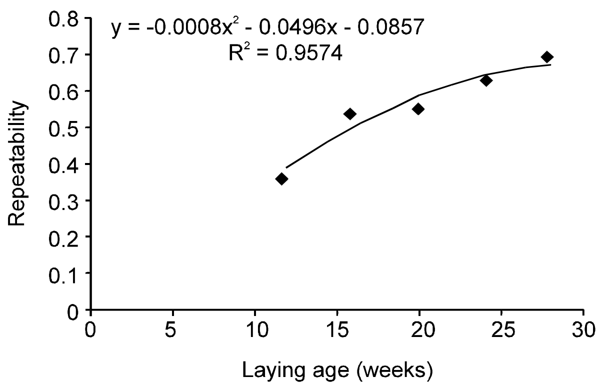

Fig. 7: Relationship between repeatability of shell membrane thickness and laying age (weeks).

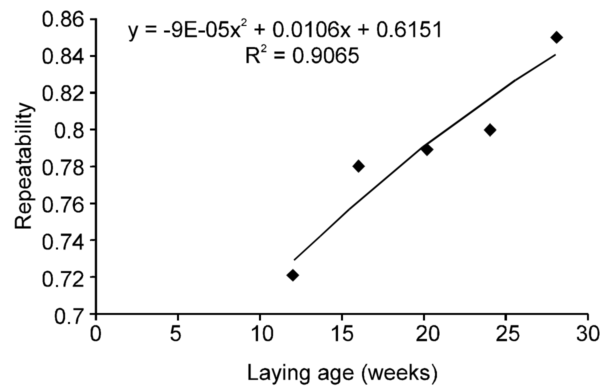

Fig. 9: Relationship between repeatability of yolk index and laying age (weeks).

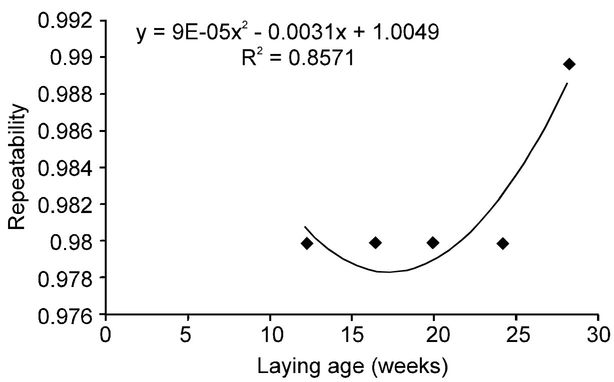

Fig. 8: Relationship between repeatability of albumen index and laying age (weeks).

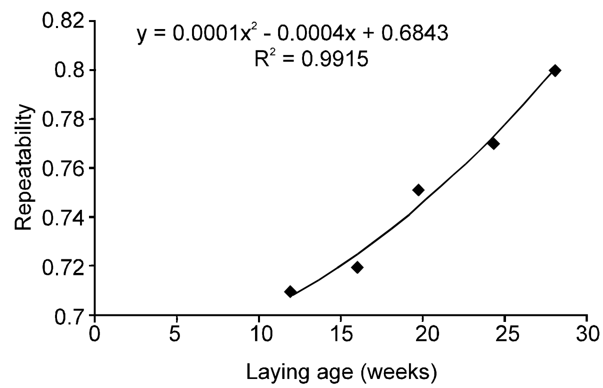

Fig. 10: Relationship between repeatability of haugh unit and laying age (weeks).

repeatability is that fewer records will be required to characterize the inherent transmitting ability of individuals. This leads to some savings in the cost of collecting additional data.

From the comparative efficiencies expressed in this study, the relationship between laying age and the repeatability of egg length, yolk and albumen weight, egg index and shape index can be effectively predicted using both liner and quadratic models. On the other hand, the quadratic model was better fitted for predicting the relationship between laying age and repeatability of egg weight, yolk weight, albumen weight, shell thickness, shell membrane thickness, albumen index and yolk index.

From the regression of the better-fitted models, there were indications that repeatability of egg length, egg index and shape index increased linearly with laying age. The rate of increase was 0.0025, 0.0065 and 0.0065 units per week, respectively. However, the repeatability of egg weight, albumen weight, yolk weight, shell thickness, shell membrane thickness, albumen index and yolk index, on age of birds showed curvilinear relationships. Thus, indicating that there is an age at which repeatability in these traits is maximum. This implies that it would be at this maximum repeatability age that the prediction of most probable transmitting ability of individuals for the traits under consideration for selection purposes is best done. This age was 28 weeks for repeatability of egg weight, yolk weight, shell thickness, shell membrane thickness, albumen index and yolk index and 24 weeks for albumen weight.

Conclusion: The repeatability estimates of egg traits in Japanese quails were high, indicating that fewer records would be required to characterize the inherent transmitting ability of these quails. The repeatability of the traits increased as laying period progressed, thus indicating progressive maternal influence on these traits with advance in age. The age at which repeatability of these traits could be estimated with maximum efficiency was 28 weeks for shell thickness, shell membrane thickness, albumen index and yolk index and week 24 for albumen weight.

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