PHENOTYPIC CORRELATIONS BETWEEN EGG QUALITY TRAITS OF THE JAPANESE QUAIL IN A SEMI-ARID AREA OF NIGERIA

ABDULRAHEEM, A.O., RAJI, A.O. AND ALADE, N.K.
Department of Animal Science, University of Maiduguri, Maiduguri, Nigeria

ABSTRACT

Phenotypic correlations between egg quality traits in Japanese quail were studied at the poultry unit of the livestock teaching and research farm, University of Maiduguri, Maiduguri. Two hundred and twenty (220) eggs were collected from 110 quail hens at 20 weeks of age. The values related to egg weight, shell weight, shell ratio, average shell thickness, egg shape index, egg surface area and shell weight per unit surface area were 9.77 g, 0.90 g, 9.29 %, 0.217 mm, 83.0 %, 21.98 cm^2 and 44.30 mg/ cm^2, respectively; while weight, height, index, and ratio and weight, height, diameter and ratio and Haugh Unit were 5.45 g, 3.95 cm, 6.58 %, 55.72 %, 3.41 g, 1.00 cm, 2.48 cm, 34.98 % and 87.77 %, respectively. Egg weight had positive correlations with both external and internal quality traits indicating that it may be the best trait for improving others. Most internal quality traits had negative correlations with shell ratio, implying that selection for internal quality traits of quail eggs could result in low shell quality. Selection to improve albumen weight will have an antagonistic effect on yolk ratio because negative correlation was observed between them. Shell ratio had negative correlations with some albumen qualities whereas it was positive with yolk quality traits implying that eggs selected for albumen quality may have poor shell quality. However, the quality may be improved if some yolk traits are considered in such selections.

Key words: phenotypic correlation, egg quality traits, egg weight.

INTRODUCTION

The significance of animal protein in sufficient and balanced nourishment is considerable for human health with respect to physical and mental processes. Among such animal protein sources, poultry has a significant role to play (Kul and Seker, 2004). It has been observed in poultry breeding that quail were as important as hens for their meat and eggs. Although, meat production was considered more common, egg is more important in some countries (Kul and Seker, 2004) especially in the developing countries, Nigeria being a good example. This is because the quality and quantity of hatching eggs have an overall significance for the continuity of the flock and economic returns (Sogut *et al.*, 2001; Sezer, 2007). Japanese quail (*Cuturnix coturnix japonica*), the smallest farmed avian species (Panda and Singh, 1990) is becoming more important for egg and meat production (Sezer, 2007). They are hardy birds and in-expensive to raise (Randall and Bolla, 2008). Other distinct features are fast growth, early maturity, high rate of egg production, short generation interval and short incubation period (Sezer, 2007). In addition, they are fairly disease resistant (Randall and Bolla, 2008). The age at point of lay for these birds range from 6 to 8 weeks (Sezer, 2007; Randall and Bolla, 2008), and with proper care, quail hens can lay between 200 and 350 eggs in their first year (Oluyemi and Roberts, 2000; Randall and Bolla, 2008).

Traits related to both external and internal qualities of eggs have significant effects on the hatchability and development of the chicks. Thus, these traits influence subsequent growth and reproductive performance of the birds. Although, the external and internal quality traits of eggs of hens as well as the correlation between these traits were previously studied, few studies have been carried out on these traits of importance in Japanese quail in Nigeria. The intent of this work was therefore to estimate phenotypic correlations between egg quality traits of the Japanese quail.

MATERIALS AND METHOD

Experimental location: The study was carried out at the Poultry Unit of the University of Maiduguri Livestock Teaching and Research Farm, Maiduguri, Borno State, Nigeria. Maiduguri, the Borno State capital is situated on latitude $11^{0}5'$ N, longitude $13^{0}09'$ E and at an altitude of 354 m above sea level. The area falls within the Sahelian region of West Africa, which is noted for great climatic and seasonal variations. It has very short period (3 – 4 months) of rainfall of 645.9 mm/annum with a long dry season of about 8 – 9 months. Relative humidity is usually 45% in

August and drops to about 5% in December and January. Day length varies from 11 to 12 hours.

Experimental birds: Two hundred and twenty eggs collected from one hundred and ten 20 week old wild-type Japanese quail were used for the study.

Data collection : The egg weight was measured with a 0.01g sensitive electronic scale. Egg height and width were measured with a Vernier caliper. Thereafter, the internal components of the 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, diameter and albumen length, width and height were taken using a Vernier caliper. After these measurements, the yolk was carefully separated from the albumen by puncturing the albumen then the yolk weight was measured with a weighing scale. Egg shell (after removing the internal components) was carefully washed to remove the remaining albumen air dried for 24 hours and weighed using an electronic scale (0.01 g sensitive). Samples taken from sharp, blunt and equatorial parts were measured for the average value of the three parts. Other traits were computed as follow:

$$S = 3.9782\ W^{0.75056}$$

Where S= Egg surface area (cm^2), W= Egg weight (mg)

$$\text{Shell weight per unit surface area}(mg/cm^2) = \text{shell weight (mg)/Egg surface area}$$

$$\text{Egg shape index} = \frac{\text{Egg width}}{\text{Egg length}} \times 100$$

$$\text{Shell ratio} = \frac{\text{shell weight (g)}}{\text{Egg weight (g)}} \times 100$$

$$\text{Albumen index} = \frac{\text{Albumen height}}{\text{Albumen width}} \times 100$$

$$\text{Yolk index} = \frac{\text{Yolk height}}{\text{Yolk width}} \times 100$$

$$\text{Yolk ratio (\%)} = \frac{\text{Yolk weight (g)}}{\text{Egg weight (g)}} \times 100$$

$$\text{Albumen weight (g)} = \text{Egg weight (g)} - (\text{yolk weight (g)} + \text{shell weight (g)})$$

$$\text{Haugh unit (HU)} = 100 \log - (H + 7.57 - 1.7W$$

Where H= Albumen height (mm), W= Egg weight (g). **Data analysis:** Data were analysed using the correlation subroutine of SPSS 13.0. Means and standard errors were computed with the same software.

RESULTS AND DISCUSSION

The descriptive statistics related to the quality traits of the examined eggs in this study are presented in Table 1. The values related to egg weight, shell weight, shell ratio, average shell thickness, egg shape index, egg surface area and shell weight per unit surface area were 9.77 g, 0.90 g, 9.29 %, 0.217 mm, 83.0 %, 21.98 cm^2 and 44.30 mg/ cm^2 respectively; while albumen weight, height, index, and ratio, yolk weight, height, diameter, and ratio and, Haugh Unit are 5.45 g, 3.95 cm, 6.58 %, 55.72 %, 3.41 g, 1.00 cm, 2.48 cm, 34.98 % and 87.77 %, respectively.

In this study, both yolk and albumen constituted over 90 % of the total weight of egg. This is an indication that yolk and albumen weight make up a higher proportion of total egg weight (Sezer, 2007). The mean observed in this study for egg weight (9.77 g) is similar to 9.60 g reported by Jibril (2008) in Japanese quail. In contrast, it was lower than 11.28 g and 11.06 g reported by Kul and Seker (2004) and Sezer (2008), respectively. The mean albumen weight reported in this study (5.45 g) is lower than those of other researchers (6.73 g, Sezer (2008); 7.80 g, Kumari *et al.* (2008)). On the other hand, mean of yolk weight (3.41 g) was similar to 3.68 g and 3.38 g reported by Kul and Seker (2004) and Sezer (2008), respectively. Kumari *et al.* (2008) however reported higher mean of 4.47 g. This may be because the birds used for their research had undergone selection for dam age at first egg. Similarly, the reasons for variations in the values obtained for both external and internal traits may not be farfetched from variations in age, environment as well as the genetic constitution of individual birds.

Phenotypic correlations between external egg quality traits

Estimates of phenotypic correlations between external egg quality traits are shown in Table 2. Egg weight had positive phenotypic correlation with other external traits except egg shape index and shell weight per unit surface area (SWUS). The result implied that egg weight maybe the best trait for improving these external quality traits. Similar observations were made by Kul and Seker (2004) and Sezer (2007). Similarly, positive correlation was observed between shell weight and all other external qualities. However, there was negative correlation between shell ratio and most external quality traits. This may mean that selection made on the external quality traits may have adverse effects on some shell qualities. The phenotypic correlations between egg weight and external qualities were in conformity with the report of Kul and Seker (2004) at 20 weeks of age in Japanese quail. The moderate correlation of 0.42 obtained between egg width and egg shape index at 20 weeks of age in this study is similar to 0.40 reported by Jibril (2008) at the same age. This was however higher than 0.34 and 0.28 reported by Kul and Seker (2004) and Sezer (2007) at 20 and 12 weeks of age, respectively in Japanese quail.

Phenotypic correlations between internal egg quality traits: Phenotypic correlations between internal egg quality traits are presented in Table 3. Albumen weight had positive phenotypic correlations with the internal qualities except for albumen height, yolk weight, yolk index, yolk ratio and Haugh unit. Similarly, positive correlations were obtained between albumen height and most internal quality traits. This positive correlation among various internal quality traits implies that the traits selected for improvement in one will lead to improvement on the other. The significant positive correlation (0.42) obtained in this study between yolk height and albumen height was close to 0.49 and 0.45 reported by Ozcelic (2002) and Sezer (2008), respectively. However, lower estimate of 0.34 has been reported by Jibril (2008) between the same traits. Albumen height and Haugh unit correlated positively (0.97) as obtained in this study. Ozcelic (2002) reported similar value. However, Sezer (2008) report a slightly lower value (0.88). High positive correlation is expected between Haugh unit and albumen as Haugh unit is calculated from albumen height and it is a good estimator of albumen quality. Significant negative correlation (-0.71) was observed between albumen weight and yolk ratio. This revealed that selection to improve albumen weight will have an antagonistic effect on yolk ratio. Kul and Seker (2004) reported high negative correlation of -0.52 which conforms with the result of this study though lesser in magnitude.

Phenotypic correlations between external and internal egg quality traits: The results of the phenotypic correlations between external and internal quality traits of egg are presented in Table 4. Egg weight had positive correlations with the internal quality traits except Haugh Unit and yolk index. Similarly, albumen width and height were positively correlated with most external quality traits. According to these results, selection for improvement in egg weight can lead to improvement in the internal quality traits. In other words, as egg weight increases, both yolk and albumen weight also increase and such correlation could be employed to improve hatchability and chick quality which are known to be influenced by yolk and albumen qualities. The positive correlation observed between egg weight and yolk ratio conforms to the report of Sezer (2008). However, the results were contrary to the findings of Ozcelic (2002). There were negative correlations between shell ratio and some albumen qualities. In contrast, shell ratio had positive correlation with most yolk qualities except yolk ratio and index. This means that egg selected for these albumen qualities may lack good shell quality. Mean while, if some yolk traits are considered in such a selection, the shell quality would be better.

Conclusion

Egg weight appears to be the best trait to improve both external and internal traits of Japanese quail eggs laid at 20 weeks of age. Selection for internal traits may lead to eggs of poor shell quality. Selection for improvement based on albumen weight would have an antagonistic effect on yolk qualities while if some yolk traits are included in such a selection, eggs of better qualities would result.

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Table 1: Descriptive statistics for external and internal quality characteristics of Japanese quail egg (X±SE) at age 20 week

Traits N=220	Means and Standard error
Egg weight (g)	9.77 ±0.07
Egg height (cm)	2.97± 0.01
Egg width (cm)	2.43±0.01
Shell weight (g)	0.90±0.01
Average shell thickness (mm)	0.27±0.12
Shell ratio (%)	9.29±0.06
Egg surface area (cm^2)	21.98±0.12
Egg shape index (%)	83.0±0.01
Shell weight per unit surface area (mg cm^2/)	44.33±0.08
Albumen length (cm)	4.38 ±0.039
Albumen height (cm)	3.95±0.04
Albumen width (cm)	3.46±0.04
Albumem weight (g)	5.45±0.06
Yolk height (cm)	1.00 ±0.01
Yolk diameter (cm)	2.48±0.01
Yolk weight (g)	3.41±0.04
Albumen ratio (%)	55.72±0.38
Yolk index (%)	40.59±0.32
Yolk ratio (%)	34.98±0.36
Haugh unit (%)	87.77±0.26
Albumen index (%)	6.58±0.10

Table 2: Phenotypic correlations between external egg quality characteristics of Japanese quail at 20 weeks

Traits	EW	HE	WE	SW	AST	SR	ESA	ESI	SWUS
EW									
HE	0.43								
WE	0.46	0.28							
SW	0.23	0.25	0.25						
AST	NA	0.18	0.16	0.49					
SR	0.09	-0.27	-0.02	0.50	0.18				
ESA	-0.04	0.51	0.29	0.57	0.37	-0.42			
ESI	-0.18	-0.75	0.41	-0.07	-0.07	0.21	-0.26		
SWUS	-0.18	0.51	0.28	0.57	0.37	-0.42	1.00	-0.26	

EW= Egg weight, HE= Egg height, WE= Egg width, SW= Shell weight, AST= Average shell thickness, SR= Shell ratio, ESA= Egg surface area, ESI= Egg shape index, SWUS=Shell weight per unit surface area

Table 3: Phenotypic correlations between internal egg quality characteristics of Japanese quail at 20 weeks

Traits	AL	AH	WA	AW	YH	YD	YW	AR	YI	YR	HU	AI
AL												

AH	0.24										
WA	0.55	0.38									
AW	0.02	-0.01	0.04								
YH	0.25	0.42	0.15	0.17							
YD	0.25	0.25	0.23	0.26	0.10						
YW	0.13	0.14	0.17	-0.15	0.22	0.25					
AR	-0.07	-0.10	-0.10	0.76	-0.02	0.00	-0.75				
YI	-0.05	0.17	-0.03	-0.02	0.77	-0.54	0.02	-0.02			
YR	0.07	0.11	0.08	-0.71	0.04	0.04	0.79	-0.98	0.01		
HU	0.22	0.97	0.33	-0.18	0.35	0.16	0.02	-0.14	0.18	0.13	
AI	-0.68	0.46	-0.21	0.03	0.21	-0.05	0.03	-0.01	0.21	0.02	0.45

AL= Albumen lenght, AH= Albumen height, WA= Albumen width, AW= Albumen weight, YH= Yolk height, YD= Yolk diameter, YW= Yolk weight, AR= Albumen ratio, YI= Yolk index, YR= Yolk ratio, HU= Haugh unit, AI= Albumen index

Table 4: Phenotypic correlations between external and internal egg quality characteristics of Japanese quail at 20 weeks

External Internal	EW	HE	WE	SW	AST	SR	ESA	ESI	SWUS
AL	0.26	0.12	0.09	0.15	-0.08	0.06	0.10	-0.03	0.09
AH	0.10	-0.06	0.17	0.09	0.07	0.02	0.08	0.20	0.08
WA	0.10	-0.06	0.15	0.28	0.11	0.17	0.15	0.05	0.16
AW	0.58	0.42	0.19	0.29	0.16	-0.50	0.79	-0.25	0.78
YH	0.27	0.08	0.17	0.18	0.21	-0.11	0.29	0.07	0.29
YD	0.59	0.22	0.21	0.15	0.19	-0.22	0.38	-0.05	0.38
YW	NA	0.24	0.17	0.40	0.32	-0.07	0.49	-0.08	0.49
AR	0.10	-0.12	0.01	-0.15	-0.14	-0.37	0.19	-0.12	0.19
YI	-0.12	-0.09	-0.01	0.05	-0.12	0.05	-0.01	0.09	-0.09
YR	0.05	-0.08	-0.01	0.07	0.12	0.21	-0.13	0.09	-0.13
HU	-0.08	-0.18	0.11	-0.04	-0.02	0.12	-0.15	0.26	-0.15
AI	0.27	-0.09	0.04	-0.02	0.11	-0.06	0.04	0.13	0.04

EW= Egg weight, HE= Egg height, WE= Egg width, SW= Shell weight, AST= Average shell thickness, SR= Shell ratio, ESA= Egg surface area, ESI= Egg shape index, SWUS=Shell weight per unit surface area, AL= Albumen length, AH= Albumen height, WA= Albumen width, AW= Albumen weight, YH= Yolk height, YD= Yolk diameter, YW= Yolk weight, AR= Albumen ratio, YI= Yolk index, YR= Yolk ratio, HU= Haugh unit, AI= Albumen index