Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.3, No.10, 2013

Phenotypic Correlation Between the External and Internal Egg Quality Traits of Pharaoh Quail Reared in Derived Savanna Zone of Nigeria

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Abstract
This study was aimed at determining the internal and external quality traits of Japanese quail eggs as well as the phenotypic correlation between these traits. A total of 360 eggs collected between the first six weeks of the laying circle were used for this study. Data obtained for external egg quality traits: egg weight (EW), egg length (EL), egg breadth (EB), shell weight (SW), shell thickness (ST)) and internal egg quality traits yolk weight (YW), yolk length (YL), yolk height (YH), yolk index (YI), albumen weight (AW) and albumen height (AH)). The mean values related to EW, EL, EB, SW and ST were as 8.1g, 2.98cm, and 2.43cm, 0.94mm, and 0.14mm respectively. YW, YL,YH, YI, AW and AH were found respectively as 2.29g, 2.10cm, 0.79cm, 0.39cm, 4.95g, and 4.96mm. Significant ($P < 0.01$) positive correlation existed between the EW against the EL, EB and SW. Also significant ($P < 0.05$) positive correlation was between EL and EB. Significant ($P < 0.01$) positive correlation existed between the YW and YL, YH and YI with significant ($P < 0.05$) positive correlation between YI and AH. The results suggest that the egg weight is a possible determinant of most of the external egg quality traits of quail egg. Egg weight therefore, is a good determinant of egg shell quality in quail egg and changes all occurred in internal egg quality of quail.
Keywords: Pharaoh quail eggs, external quality trait, internal quality trait, phenotypic correlation, derived savanna zone

1. Introduction

The phenotypic correlation between any two quantitative traits describes the extent to which individuals above average for one trait tend to be above, below or near the average for the other traits (Pirchner, 1984). It measures the linear association between traits that is it predicts the deviation from the population mean in one trait of an individual as a function of its deviation from the population mean of other when both traits are measured in their respective phenotypic standard deviation units. Gihan and Ensaf, (2012) reported that the knowledge of correlations among productive traits is essential for the construction of selection indices designed to maximize the rate of genetic improvement.

Phenotypic characteristic for egg quality traits of external and internal type is important mainly for interest of economy of production. The attention of many researches was devoted especially to egg quality, because crack egg shell presents high loses for market egg producers especially if eggs are produced from aged hens in the second laying cycle. Therefore is very important to evaluate the quality characteristics of eggs and the age factor which can affect them. The genotype and the age factor could be the most important factors influencing not only egg weight, but also the other (external and internal) egg characteristics (Hassan, 2009).

The Japanese Quail, also known as Coturnix quail, pharaoh's quail, stubble quail and eastern quail differs considerably from the North American Bobwhite quail. The Bobwhite is larger than the Japanese quail, however the Coturnix produces larger eggs. The incubation time needed for fertile eggs is shorter (14-17 days) compared to Bobwhite quail eggs (23 days). Coturnix may start laying eggs as early as 6 weeks of age compared to 16 weeks for the Bobwhite (Sam, 1999). In numerous researches related to the quail rearing, it was reported that 7-8% of the total number of egg broken throughout the transfer of the eggs from the breeder to consumer (Kul and Seker, 2004) and that the amount of cracked and broken eggs resulted in a serious economic problem both for the breeders and the dealers (Hamilton, 1982). In the egg processing industries the eggshell weight, albumen and the yolk that form the egg as well as their ratio affect the amount and price of the product (Actan *et al.,* 1998). The eggs weight is said to have a direct relation with the eggshell quality which has a positive correlation with the shell thickness and the shell weight (Olawumi and Ogunlade, 2008). The internal and external quality traits of eggs as well as the correlation between these traits had been studied in quails (Kul and Seker, 2004). Positive phenotypic correlation exists between egg weight and other egg biometrical traits egg length was weighty and significant correlated with egg width. The relationship between egg shape index and width is also high (Yakubu *et al.,* 2008).

The number of research covering such quality traits in Pharaoh quail, are rare in literature in this country. The increasing number in the rearing and reproduction of Pharaoh quail formed the desire to examine such issues that relate to internal and external egg qualities traits of Pharaoh quail and the phenotypic correlation associated with these qualities traits.

2. Materials and Methods

2.1 Site of Experiment

The research was carried out at the Poultry unit of Teaching and Research Farm Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria. Ogbomoso is a derived Savanna zone of Nigeria lies within the latitude $8^{0}15^{1}$ and longitude 4^{0} 15^{1}, the area has an annual rainfall of 1247mm, with altitude between 300-600metres above the sea level while the mean annual temperature is about 27^{0}C (BATC, 2004).

2.2 Birds and Husbandry

A total of 200 day-old chick of Pharaoh quail (*Coturnix, coturnix Japonical*) were purchased at day old from Foresight Hatchery Nigeria Limited, Oluyole Industrial Estate, Ibadan. These birds were kept under normal littered condition in brooding floor pens until they were three weeks of age and with a gradual decrease in room temperature from 37^{0}C to 25^{0} at six weeks of age.

2.3 Feeds and Feeding

The birds were fed ration containing 28% cruse protein and 2800 Kcal ME/Kg at age 0-4 week while 24% crude protein and 2800 Kcal ME/Kg diet was offered at 4-8 weeks and 18% crude protein and 2700kcal ME/Kg diet at 9 weeks will the end of the experiment which lasted for 12 weeks .

2.4 Data Collection

Parameters collected include, egg weight (g), egg length (cm), egg breadth (mm), shell weight (g), shell thickness (mm), for external quality traits and yolk weight (g), yolk length (cm), yolk height (cm), yolk index (mm), albumen weight (g), albumen height (mm) for internal egg qualities traits

2.5 Data Analysis

All data collected were subjected to analysis of variance using the General Linear Model of SAS (2003). An animal model was constructed as follows:

$Y_{ij} = \mu + a_i + e_{ij}$

where

Y_{ij} is the ijth average phenotypic record of the egg quality trait,

μ is the common mean,

a_i is the ith individual measurement of the trait

e_{ij} is the error.

With the Pearson moment correction coefficient model.

$$r = \frac{\sum XY}{(\sum X^2 \sum Y^2)^{0.5}}$$

where r = correlation coefficient

$\sum X^2, \sum XY and \sum Y^2 =$ sumof variables

3. Results and Discussion

3.1 Results

Table 1 revealed the egg weight, egg length egg breadth, shell weight and shell thickness which were as 8.19g, 2.98cm, 2.43cm, 0.94g and 0.14mm respectively. Yolk weight, yolk length, yolk height, yolk index, albumen weight and albumen height were found, respectively as 2.29g, 2.10cm, 0.79cm, 0.39cm. The Coefficient of Variation % for most traits were generally less than 10%. Those with greater Coefficient of Variation % were egg weight and albumen weight.

Table 2 shows the phenotypic correlation coefficient of external egg quality trait of Japanese quail. Significant ($P<0.01$) positive correlation of 0.21, 0.27, 0.17, and 0.22, respectively were found between egg weight against egg length, egg breadth, and shell weight. Also significant ($P<0.05$) positive phenotypic correlation (0.12) was obtained between egg breadth and egg length. The non-significant but negative phenotypic correlation values obtained between the shell thickness against egg weight and egg breadth.

Phenotypic correlation coefficient of internal egg quality trait of Japanese quail birds were shown in Table 3. Significant ($P<.001$) positive correlations of 0.25 and 0.71, respectively were obtained between yolk length and yolk weight, as well as yolk index and yolk height whereas significant ($P<0.01$) negative phenotypic correlation value (-0.27) was only obtained between yolk index and yolk length. The significant ($P<0.05$) positive correlation value (0.12) was only found between yolk index and albumen height. Meanwhile, non- significant positive phenotypic correlation of 0.09 were obtained between yolk height and yolk weight whereas non-significant but negative phenotypic correlation of -0.06, -0.04, -0.04, -0.03, and -0.09, respectively were obtained between yolk weight and yolk index, albumen height against yolk weight and yolk length, albumen weight and yolk weight.

3.2 Discussion

The pattern of variation that exists for descriptive statistics of external egg quality traits of quail, birds were similar to the findings of Ingram *et al.,* (1989). These authors obtained ranged of values similar to this present study for egg characteristics of the Bobwhite quail. The external egg quality trait displayed low, positive phenotypic correlation for egg weight against egg length, egg breadth and shell weight which were also in line with the previous research of Ingram *et al.,* (1989). Thus, shell weight has a direct relation with egg length, egg breadth and this direct relationship of egg weight had been earlier reported for laying birds by Wilkanowska and Kokoszynski (2012) who reported that the egg weight values were more appropriate in determining the shell quality because the shell thickness and shell weight are measured after breaking of the egg and it took time to make such measurements. The positive phenotypic correlation displayed among egg breadth and egg length in this present study collaborated the finding of Yannakopoulos and Tserveni-Gousi (1986) who reported that these egg traits could be used as a criterion for determining the stiffness of eggshell.

Meanwhile, the result of internal egg quality with low but positive correlation and non- significant negative correlation reveals were similar to the results reported by Ingram *et al.,* (1989). These authors obtained most phenotypic correlations which were positive but close to zero and negative internal egg quality traits phenotypic correlation which were also closed to zero unit. The negative but non-significant correlation between most of the internal egg quality traits was similar to the findings of Kul and Seker, (2004). However, the pattern of variation for all the internal egg quality trait phenotypic correlations were similar with the findings of Wilson and Douglas, (1983) for Bobwhite quails.

4. Conclusion

The results from this present study on phenotypic correlation of quail birds suggest the egg weight is possible in determining most of the external egg quality traits of quail eggs. Egg weight therefore, is a good determinant of eggshell quality in quail eggs and changes that occurred in internal egg quality traits of quail eggs.

5. Recommendation

The phenotypic correlation in this study on quail eggs reveals that most of economically important traits studied were quite similar to extensive research in chickens. Similar selection program in the quail birds seem promising.

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Table 1: Descriptive Statistics of Egg Quality Traits

Variables (n = 360)	Mean ± S.E	Minimum	Maximum	Coefficient of Variation %
External Egg Quality				
EW (g)	8.19± 0.02	8.00	8.10	1.50
EL (cm)	2.98 ±0.35	2.55	3.05	0.06
EB (cm)	2.43±0.16	2.24	2.45	0.05
SW (g)	0.94±0.00	0.91	1.00	0.03
ST (mm)	0.14±0.03	0.11	0.16	0.01
Internal Egg Quality				
YW (g)	2.29±0.04	2.00	3.00	0.30
YL (cm)	2.10±0.02	1.92	2.22	0.04
YH (cm)	0.79±0.01	0.70	1.00	0.03
YI (cm)	0.39±0.03	0.38	0.55	0.00
AW (g)	4.95±0.14	3.54	6.51	1.06
AH (mm)	4.96±0.35	3.12	5.00	0.06

n = number of Egg used EW = egg weight, EL = egg length, EB = egg breadth, SW = shell weight, ST = shell thickness, YW = yolk weight, YL = yolk length, YH = yolk height, YI = yolk index, AW = albumen weight,
AH = albumen height.

Table 2: Phenotypic Correlation Coefficient of External Egg Qualities of Pharaoh Quail

VARIABLES	EW	EL	EB	SW	ST
EW	-				
EL	0.21**	-			
EB	0.27**	0.12*	-		
SW	0.17**	0.01	0.22**	-	
ST	-0.08	0.01	-0.02	0.01	-

**$P < 0.01$ = Correlation is significant at the 0.01 level (2 - tailed).
*$P < 0.05$ = Correlation is significant at the 0.05 level (2 - tailed)
EW = egg weight, EL = egg length, EB = egg breadth, SW = shell weight, ST = shell thickness.

Table 3: Phenotypic Correlation Coefficient of Internal Egg Qualities of Pharaoh Quail

VARIABLES	YW	YL	YH	YI	AH	AW
YW	-					
YL	0.25**	-				
YH	0.09	0.07	-			
YI	-0.06	-0.27**	0.71**	-		
AH	-0.04	-0.03	0.06	0.123*	-	
AW	-0.09	0.04	0.06	0.037	-0.02	-

**$P < 0.01$ = Correlation is significant at the 0.01 level (2 - tailed).
*$P < 0.05$ = Correlation is significant at the 0.05 level (2 - tailed)
YW = yolk weight, YL = yolk length, YH = yolk height, YI = yolk index, AH = albumen height, AW = albumen weight.