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Phenotypic Correlations between External and Internal Egg Quality Traits of Coturnix Quails Reared under Intensive Housing System

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Authors' contributions

This work was carried out in collaboration between both authors. Author SO designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author BC managed the analyses of the study. Both authors read and approved the final manuscript.

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ABSTRACT

Aims: The present study investigated phenotypic correlations between external and internal egg quality traits in Japanese quail.
Study Design: Laboratory analysis was carried out using sensitive scale and Vernier calipers.
Place and Duration of Study: Teaching and Research Farm, Department of Animal Production and Health Sciences, Ekiti State University, between September 2013 and December, 2013.
Methodology: The quails were housed in the cage at the ratio of 1 male: 3 females. Freshly laid eggs were collected and taken to the laboratory for external and internal analysis. Egg weight was taken with sensitive scale, while egg length and egg width were taken with Vernier calipers. Thereafter, the eggs were broken at equatorial region and the contents poured into a dish. Subsequently, egg yolk weight, length and width, albumen length and width were measured, while albumen weight was obtained by subtracting the addition of yolk weight and shell weight from egg weight.
Results: Results revealed that egg weight has no significant phenotypic correlation with egg width, egg length, shell weight and shell thickness (P>0.05). With regard to internal egg quality traits,

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albumen weight was found statistically insignificantly correlated with all internal qualities including Haugh unit. In the case of albumen height, positive and highly significant phenotypic correlation was recorded with Haugh unit. The implication is that albumen height is a good determinant of Haugh unit. The higher the value, the higher the Haugh unit score, and the better the quality of an egg. However, the trait has negative and significant phenotypic correlation with albumen width, yolk weight and yolk width. In addition, egg weight has positive statistically significant phenotypic correlation with albumen and yolk indices (P=0.01).

Conclusion: The size of an egg determines its albumen and yolk proportions. Egg weight therefore, is a good determinant of albumen weight and yolk weight in quail bird.

Keywords: Japanese quail; egg quality; Haugh unit; phenotypic correlation.

1. INTRODUCTION

In farm animals, traits of economic interest are measured and correlations between them determined in order to know the degree of association between them which could be of help in any selection programme. It has been asserted that 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 [1]. For maximization of the rate of genetic improvement, knowledge of correlation among productive traits is essential for the construction of selection indices [2].

Egg quality is composed of those characteristics of an egg that affects its acceptability to domestic or industrial consumers. Both external and internal egg quality traits in poultry hens [3] and quails [4] had significant effects on the hatchability of incubated eggs, body weight and development of young chicks. Similarly, Islam et al. [5] posited that egg quality has significant effect on reproductive fitness of parents. In the egg processing industry, weights of eggshell, albumen and yolk that form the major components of an egg as well as their rates affect the amount and price of the product [6].

Previous investigations had established positive association between egg weight and other external and internal egg qualities. In Isa Brown layer breeders, it was reported that egg weight has positive significant phenotypic correlation with external egg qualities such as egg length, egg width and shell weight [7]. The authors also found positive phenotypic correlation between egg weight and internal egg qualities such as albumen weight, albumen width, yolk weight and yolk width. In addition, positive significant phenotypic correlation value was recorded between albumen height and Haugh unit by the afore-mentioned authors. The findings of the authors were consistent with those of previous workers [8,9].

In the more recent and related study on quail eggs, Zita et al. [10] observed positive phenotypic correlation between egg weight and yolk weight, albumen weight and eggshell weight. The authors also found positive phenotypic correlation between albumen index and Haugh unit. On the other hand, Zita et al. [10] observed negative but significant phenotypic correlations between egg weight and yolk proportion, egg weight and shell proportion, albumen weight and yolk proportion and albumen weight and eggshell proportion. Haugh unit score according to Kondaiah et al. [11] is considered the best objective mathematical expression to measure egg quality. In a related study on Pharaoh Quails, positive phenotypic correlation was found between egg weight and external egg quality traits. The author equally found significant positive phenotypic correlation between yolk weight and yolk length [12].

The increasing number of hatchery industries producing day-old quails necessitated this study in order to examine the relationship among egg quality traits that have direct positive influence on the quality of hatchery products.

2. MATERIALS AND METHODS

2.1 Study Area

The study was carried out at the Animal Breeding unit, Teaching and Research Farm, Ekiti State University, Ado-Ekiti. Ado-Ekiti is situated along latitude 7°31 ^{1} and 7°49 ^{1} North of the Equator and longitude 5°71 ^{1}and 5°27 ^{1}East of the Greenwich Meridian. The city falls under Derived Savannah zone. The city enjoys two separate seasonal periods namely, Rain (May-October) and Dry (November-April) seasons.

2.2 Experimental Birds and Management

A total number of 100 Coturnix quails used for this study were reared inside the specially constructed cages on our experimental farm. The birds were raised under similar nutritional status, uniform management and environmental conditions. They layers were given mash containing 16%CP and 2600 Kcal/kg ME throughout the laying period. Feed and water were supplied *ad libitum.*

2.3 Data Collection and Laboratory Analysis

Freshly laid eggs were collected and weighed using a 0.01 sensitive digital scale, while the length and width of egg were measured with digital Vernier caliper. After taken the external measurements of the eggs, the sharp end was carefully broken and the contents poured into a flat plate in order to measure albumen and yolk indices. The yolk is then carefully separated from the albumen and placed on the scale for weighing. The plate was wiped dry after each weighing. The shell weight with membrane was obtained by carefully placing the material on the sensitivity scale, while the thickness of the shell without membrane was measured using digital Vernier caliper. Other egg quality traits were obtained by mathematical calculations, and these include:

Albumen weight= egg weight- (yolk weight + shell weight)

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

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

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

Haugh unit [13] = $100\log (H+7.57-1.7W^{0.37})$

H= albumen height (mm)
W= weight of egg (g)

The phenotypic correlation values related to internal and external egg quality traits of an egg were determined by the Pearson Correlation Analysis of the SAS statistical package [14].

3. RESULTS AND DISCUSSION

The mean values related to egg weight, egg width, egg length, shell weight, shell thickness and shell ratio respectively, were 10.5 g, 2.61 cm, 3.33 cm, 1.13 g, 0.09 cm, 10.84%. With regard to internal egg quality traits, the mean values were 5.13 g, 0.88 cm, 3.31 cm, 49.09%, 4.25 g, 1.42 cm, 2.54 cm, 40.07%, 107.98 respectively, for albumen weight, albumen height, albumen width, albumen ratio, yolk weight, yolk height, yolk width, yolk ratio and Haugh unit score (Table 1). The results showed a greater proportion of albumen (49.09%) as compared to yolk (40.07%) and shell (10.13%). The average values reported for external and internal egg quality traits were similar with the previous findings [9,15], but differed from those of [16,17]. The differences between the mean values obtained in this study and the previous studies might be due to differences in genetic structure, flock age, feeding regimes, health condition, and care and management practices.

Table 2 shows the phenotypic correlations between external egg quality traits. There was statistically non-significant (P>.05) phenotypic correlations between egg weight and egg length. Similar non-significant phenotypic correlation values were obtained between egg weight and other external egg quality traits. Pertaining to exterior egg indices, there were no significant (P>.05) phenotypic correlations between them with the exception of shell weight which has positive significant (P=.001) phenotypic correlation with shell ratio. This implies that only shell weight could be used to determine the value of shell ratio.

In this study (Table 3), albumen weight has non-significant (P>.05) phenotypic correlations with albumen height, albumen width, yolk weight, yolk height, yolk width and Haugh unit. However, albumen height recorded negative statistically significant (P=.01) phenotypic correlations with albumen width, yolk weight and yolk width. As expected, albumen height showed positive and highly significant (P=.001) phenotypic correlation with Haugh unit. Also in the present study, albumen width has positive significant (P=.01) phenotypic correlation with yolk weight, while yolk weight showed positive significant (P=.01) correlation with yolk width, but negative significant (P=.01) correlation with Haugh unit.

Table 1. Descriptive statistics of egg qualities of Coturnix quail eggs

Traits	N.	Min.	Max.	Mean	SD
Egg weight (g)	8	9.00	12.00	10.50	0.93
Egg length (cm)	8	3.10	3.60	3.33	0.21
Egg width (cm)	8	2.40	2.90	2.61	0.20
Yolk weight (g)	8	3.00	6.00	4.25	1.04
Yolk height (cm)	8	1.00	1.80	1.42	0.31
Yolk width (cm)	8	2.10	3.00	2.54	0.30
Yolk ratio (%)	8	30.00	50.00	40.07	6.73
Albumen weight (g)	8	4.00	6.00	5.13	0.64
Albumen height (cm)	8	0.50	1.10	0.88	0.24
Albumen width (cm)	8	2.70	4.00	3.31	0.39
Albumen ratio (%)	8	40.00	60.00	49.09	7.13
Shell weight (g)	8	1.00	2.00	1.13	0.35
Shell thickness (cm)	8	0.08	0.10	0.09	0.01
Shell ratio (%)	8	8.33	20.00	10.84	3.79
Haugh unit (HU)	8	91.94	116.84	107.98	9.63

Table 2. Phenotypic correlations between external egg quality traits of Coturnix quails

Traits	Egg weight	Egg length	Egg width	Shell weight	Shell thickness	Shell ratio
Egg weight	1.00	0.5092	0.2756	-0.2182	-0.4211	-0.4278
Egg length		1.00	-0.1804	-0.2381	-0.2022	-0.3357
Egg width			1.00	0.3867	-0.1094	0.2924
Shell weight				1.00	-0.6065	0.9752***
Shell thickness					1.00	-0.4746
Shell ratio						1.00

****P<0.001*

Table 3. Phenotypic correlations between internal egg quality traits of Coturnix quails

Traits	Albumen weight	Albumen height	Albumen width	Yolk weight	Yolk height	Yolk width	Haugh unit
Albumen weight	1.00	0.2975	-0.3527	-0.2692	0.2733	-0.4030	0.2617
Albumen height		1.00	-0.7238*	-0.8786**	0.3357	-0.7548*	0.9965***
Albumen width			1.00	0.8825**	-0.1599	0.6657	-0.7505
Yolk weight				1.00	-0.2482	0.7079*	-0.9002*
Yolk height					1.00	0.0668	0.2859
Yolk width						1.00	-0.7670*
Haugh unit (HU)							1.00

**P<0.05, **P<0.01, ***P<0.001*

The present data indicated a negative, significant phenotypic correlations between albumen height and weight and width of egg yolk. The implication with this scenario is that any attempt to improve on albumen height during breeding programme will have negative effect on yolk indices. That is, yolk indices will decrease in value while albumen height is being improved upon. This was inconsistent with the findings of Kul and Seker [9] who found positive significant correlations between albumen height and yolk indices. Albumen height however, recorded very high positive significant phenotypic correlation

Table 4. Phenotypic correlations between external and internal egg quality traits of Coturnix quails

Traits	Egg weight	Albumen weight	Albumen height	Yolk weight	Yolk height	Haugh unit	Shell weight	Shell thickness
Egg weight	1.00	0.9414**	0.7680*	0.7418*	0.7263*	0.7248*	0.8586**	0.6104
Egg length		0.4241	0.2026	0.3966	0.0603	0.1301	0.4053	0.4900
Egg width		0.3484	0.3655	0.5645	0.3562	0.3578	0.5605	0.5051
Albumen weight		1.00	0.6365	0.4797	0.5890	0.5890	0.6446	0.6396
Albumen height			1.00	0.7895*	0.9746**	0.9961***	0.7321*	0.1316
Yolk weight				1.00	0.7908*	0.7780*	0.9239**	0.2727

**P<0.05, **P<0.01, ***P<0.001*

with Haugh unit in this study. This means that the latter can be used to predict the value of the former and vice versa. Haugh unit score indicates the quality and freshness of an egg, and the higher the value, the more tasty, safe and healthy the egg for consumption. An egg with lower Haugh unit shows that it has lost its freshness and quality and therefore, not good for either domestic or processing usage. The result of this study was in agreement with the observation of previous authors who reported that albumen height is a good determinant of Haugh unit [9,18].

The correlations between external and internal egg quality traits were presented in Table 4. Egg weight has positive significant (*P*=.001) phenotypic correlations with albumen weight and height, yolk weight and height, shell weight and Haugh unit score. However, both egg height and width were found not to have significant (*P*>.05) correlations with any of the interior egg quality traits. In addition, albumen height and yolk weight recorded statistically positive significant (*P*=.01) correlation with shell weight, but not with shell thickness. The striking change worth noting in this work was that Haugh unit has no significant (*P*>.05) phenotypic correlation with either shell weight or shell thickness. In addition, egg weight also has positive significant (*P*=.001) phenotypic correlation with Haugh unit. This implies that the weight of quail egg can be predicted by the size of its major components, which are albumen, yolk and shell. It is therefore, possible to determine and compare eggs of different sizes by knowing the measurements of their interior contents. Eggs with greater proportions of albumen and yolk will no doubt give higher value of egg weight in contrast to the one with lower proportion of egg components. The results of this study were in agreement with the previous findings [10,17] who found positive significant phenotypic correlations between egg weight and its component parts to be above 0.5. In contrast, Yannakopoulos and Tserveni-Gousi [15] reported a non-significant phenotypic correlations between egg weight and internal egg components. The authors found that internal egg traits could not be used to predict the weight of an egg. Kul and Seker [9] reported that almost all internal quality traits of the egg were changed at the significant levels depending on the change which occurred in the egg weight. The result of the present investigation was in conformity with the author's findings.

In the present study, yolk indices has negative but significant phenotypic correlation with Haugh unit. This suggests that any breeding programme geared towards improving yolk proportion will consequently have negative effect on Haugh unit score. The reason is that albumen and yolk proportions of an egg cannot be improved upon simultaneously in an experiment. In contrast, Kul and Seker [9] observed positive significant phenotypic correlation between yolk height and Haugh unit.

4. CONCLUSION

It was indicated in this study that egg weight has no significant phenotypic correlations with egg length and egg width, but that the latter was correlated with albumen and yolk indices. This means that albumen and yolk proportions are good determinants of egg weight. The former can be used to predict the values of the latter. In the same manner, albumen height recorded positive significant phenotypic correlations with Haugh unit score. The higher the value, the higher the quality of an egg while, lower Haugh unit indicates poor and less dense interior qualities.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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