Asian Journal of

# Poultry Science

ISSN 1819-3609

Academic
Journals Inc.

www.academicjournals.com

Asian Journal of Poultry Science 2 (1): 30-35, 2008
ISSN 1819-3609


# Phenotypic Correlations Between Some External and Internal Egg Quality Traits in the Exotic Isa Brown Layer Breeders

S.O. Olawumi and J.T. Ogunlade
Department of Animal Production and Health Sciences, University of Ado-Ekiti, P.M.B. 5363, Ado-Ekiti, Nigeria

**Abstract:** This study was aimed at determining the internal and external quality traits of the breeding eggs of Isa Brown layer breeders as well as the phenotypic correlations between these traits. A total of 120 eggs collected during the first laying cycle were used for this study. The birds were reared on deep litter at Ajanla Farm, Ibadan, Southwest, Nigeria. The values related to egg weight, egg width, egg length, shell thickness, shell ratio, shape index and shell weight were found, respectively as 55.90 g, 4.24, 5.57 and 0.27 cm, 10.05%, 76.18% and 5.62 g while yolk weight, yolk width, yolk height, albumen weight, albumen width, albumen height, haugh unit, yolk ratio and albumen ratio were found respectively as 14.35 g, 3.84 cm, 1.77 cm, 35.94 g, 6.93 cm, 8.60 mm, 93.21, 25.74 and 64.24%. According to the results obtained in this research, almost all internal quality traits of the eggs were influenced at significant levels depending on the change that occurred in the egg weight with respect to the external quality traits of the egg except yolk ratio. These results suggest that it was possible to use egg weight in determining the egg length, egg width and eggshell weight. Both yolk height and albumen height significantly influenced haugh unit and this implies that these traits could be used to determine the value of haugh unit rather than any other internal quality traits.

**Key words:** Layer breeder, egg, quality trait, phenotypic correlation

## INTRODUCTION

Poultry products such as meat and eggs are amongst the most nutritious foods and eggs are rated with milk as one of the best balanced protein foods rich in Iron (Fe) and vitamins (Oluyemi and Roberts, 2000). The significance of animal proteins in sufficient and balanced nourishment is considerable for the human health with respect to the physical and mental progress (Uluocak *et al*., 1995). Among such animal protein sources, the poultry species are prominent and domestic chicken in particular ranked first in the production of table eggs and meat. They have short generation and gestation interval, high prolificacy, fast growth rate and ease of raising (Oluyemi and Roberts, 2000). The external and internal quality traits of eggs in both hens (Hurnik *et al*., 1978; Nordstrom and Ousterhout, 1982) and quails (Narahari *et al*., 1988; Peebles and Marks, 1991) had significant effects on the hatchability of incubated and fertile eggs well as the weight and development of the laying chicks. Egg quality according to Islam *et al*. (2001) affected the reproductive fitness of the parents. In addition, external and internal quality traits of the eggs are significant in the poultry breeding for their influence on the yield features of the future generations, breeding performances and quality and growth of the chicks (Altinel *et al*., 1996; McDaniel *et al*., 1978). In numerous research related to the aforementioned subjects, it was reported that 7-8% of the total number of egg is broken throughout the transfer of the eggs from the breeders to consumers (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

**Corresponding Author:** S.O. Olawumi, Department of Animal Production and Health Sciences, University of Ado-Ekiti, P.M.B. 5363, Ado-Ekiti, Nigeria

the egg as well as their rates affect the amount and price of the product (Altan *et al*., 1998). In some other researches, the egg weight is said to have a direct relation with the eggshell quality which has a positive correlation with the shell thickness (Choi *et al*., 1983; Stadelman, 1986) and the shell weight (Choi *et al*., 1983). 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). The number of researches covering such qualities in exotic layer breeders, especially the phenotypic correlation among these traits are rare in literature in this country. The increasing number of hatchery industries which produce commercial chicks informed the desire to examine such issues related to internal and external quality traits of breeding eggs, determine the phenotypic and genetic correlations associated with these traits. This research was therefore, aimed at evaluating the internal and external quality traits of breeding eggs of exotic Isa Brown layer breeders as well as the phenotypic correlations between these traits.

## MATERIALS AND METHODS

A total of 120 fresh eggs were collected from breeder hens between March and June, 2006 for this study. The birds were raised on deep litter at Ajanla farm, Ibadan, Southwest, Nigeria. They were housed as 1 male/10 females for natural mating at the breeding unit of the farm. The breeder diet given contained 17% crude protein and 2800 kcal ME $kg^{-1}$ energy. A lighting schedule of 16 h light/day was applied.

### Methods

The eggs were numbered first and then weighed on a sensitive scale to determine their weights. Later, the width and length of the eggs were measured. Each egg was broken on a table and its contents poured into a flat plate in order to measure the yolk height and width, albumen height and width. The yolk was separated from the albumen and then weighed while the albumen weight was found by subtracting the weights of yolk and shell from egg weight.

Some internal and external quality traits of the egg were obtained using the following formulae on the basis of aforementioned measures. They are:

- Shape index (%) = (Width (cm)/Height (cm)×100
- Shell ratio (%) = (Shell weight/Egg weight)×100
- Albumen ratio (%) = (Albumen weight/Egg weight)×100
- Yolk ratio (%) = (Yolk weight/Egg weight)×100
- Albumen weight (g) = Egg weight−(Yolk weight+Shell weight)
- Haugh Unit (HU) = $100 \log (H+7.57-1.7W^{0.37})$
- H = Albumen height (mm)
- W = Egg weight (g)

The phenotypic correlation values related to the internal and external quality traits of the egg were determined by the Pearson Correlation Analysis (Snedecor and Cochran, 1980). The estimations were made using SAS (2001).

## RESULTS AND DISCUSSION

The mean values related to egg weight, egg width, egg length, shell thickness, shell ratio, egg shape index and shell weight were found, respectively as 55.90 g, 4.24, 5.57 cm, 0.27 mm, 10.05, 76.18% and 5.62 g and yolk weight, yolk width, yolk height, albumen weight, albumen width, albumen height, Haugh unit, yolk ratio and albumen ratio were found, respectively as 14.35 g, 3.84 cm, 1.77 cm, 35.94 g, 6.93 cm, 8.60 mm, 93.21, 25.74 and 64.24% (Table 1). The results indicated a greater proportion of albumen (64.24%) compared to yolk (25.74%) and shell (10.05%) of the total egg. As

Table 1: Descriptive statistics of egg quality characteristics

| Traits (n = 120) | $X \pm S_x$ | Minimum | Maximum | Coefficient of variation |
|---|---|---|---|---|
| **External egg quality traits** | | | | |
| Egg weight (g) | 55.90±4.84 | 45.27 | 68.79 | 7.83 |
| Egg width (cm) | 4.24±0.13 | 3.90 | 4.53 | 2.93 |
| Egg length (cm) | 5.57±0.26 | 4.49 | 6.28 | 4.15 |
| Shell thickness (mm) | 0.27±0.04 | 0.16 | 0.36 | 12.69 |
| Shell ratio (%) | 10.05±1.23 | 7.14 | 13.14 | 7.51 |
| Egg shape index (%) | 76.18±3.67 | 67.77 | 95.55 | 4.48 |
| Shell weight (g) | 5.62±0.87 | 3.78 | 8.03 | 9.69 |
| **Internal egg quality traits** | | | | |
| Yolk weight (g) | 14.35±1.55 | 11.00 | 17.66 | 9.68 |
| Yolk width (cm) | 3.84±0.18 | 3.34 | 4.29 | 4.56 |
| Yolk height (cm) | 1.77±0.21 | 1.00 | 2.10 | 10.85 |
| Albumen weight (g) | 35.94±3.81 | 27.15 | 46.77 | 9.89 |
| Albumen width (cm) | 6.93±0.70 | 5.10 | 8.60 | 9.01 |
| Albumen height (mm) | 8.60±0.16 | 5.40 | 19.00 | 16.32 |
| Haugh unit (Hu) | 93.21±6.96 | 76.22 | 128.45 | 6.75 |
| Yolk ratio (%) | 25.74±2.41 | 19.92 | 31.83 | 9.02 |
| Albumen ratio (%) | 64.24±2.90 | 57.26 | 70.60 | 3.71 |

Table 2: The phenotypic correlation between external egg quality traits

| External egg quality traits | Egg weight | Egg length | Egg width | Shell thickness | Shell weight | Shape index | Shell ratio |
|---|---|---|---|---|---|---|---|
| Egg weight | 1.00 | 0.66*** | 0.88*** | 0.05 | 0.61*** | -0.09 | 0.04 |
| Egg length | | 1.00 | 0.34*** | -0.10 | 0.27** | -0.79*** | -0.14 |
| Egg width | | | 1.00 | 0.10 | 0.61*** | 0.31*** | 0.14 |
| Shell thickness | | | | 1.00 | 0.74*** | 0.16 | 0.78*** |
| Shell weight | | | | | 1.00 | 0.12 | 0.82*** |
| Shape index | | | | | | 1.00 | 0.22** |
| Shell ratio | | | | | | | 1.00 |

*: p<0.05; **: p<0.0; ***: p<0.001

Table 3: The phenotypic correlation between internal egg quality traits

| Internal egg quality traits | Yolk weight | Yolk width | Yolk height | Yolk ratio | Albumen weight | Albumen length | Albumen width | Albumen ratio | Haugh unit |
|---|---|---|---|---|---|---|---|---|---|
| Yolk weight | 1.00 | 0.62*** | 0.44*** | 0.64*** | 0.18 | 0.03 | 0.22* | -0.62*** | -0.04 |
| Yolk width | - | 1.00 | 0.17 | 0.31*** | 0.21* | 0.001 | 0.05 | -0.29** | -0.07 |
| Yolk height | - | - | 1.00 | 0.08 | 0.34*** | 0.36** | -0.03 | -0.04 | 0.34*** |
| Yolk ratio | - | - | - | 1.00 | -0.63*** | -0.10 | -0.03 | 0.90*** | -0.05 |
| Albumen weight | - | - | - | - | 1.00 | 0.19* | 0.18* | 0.60*** | 0.06 |
| Albumen height | - | - | - | - | - | 1.00 | -0.35*** | 0.15 | 0.97*** |
| Albumen width | - | - | - | - | - | - | 1.00 | -0.12 | -0.41*** |
| Albumen ratio | - | - | - | - | - | - | - | 1.00 | 0.11 |
| Haugh unit | - | - | - | - | - | - | - | - | 1.00 |

*: p<0.05; **: p<0.01; ***: p<0.001

Table 4: The phenotypic correlation between external and internal quality traits of eggs

| Internal egg quality traits | External quality traits | | | | | | |
|---|---|---|---|---|---|---|---|
| | Egg weight | Egg length | Egg width | Shell weight | Shell thickness | Shell ratio | Shape index |
| Yolk weight | 0.55*** | 0.34*** | 0.48*** | 0.47*** | -0.09 | -0.18* | -0.03 |
| Yolk height | 0.45*** | 0.31*** | 0.36*** | 0.19* | -0.13 | -0.09 | -0.07 |
| Yolk width | 0.42*** | 0.28** | 0.42*** | 0.26** | 0.03 | 0.02 | -0.02 |
| Yolk ratio | -0.29** | -0.22* | -0.26** | -0.03 | -0.14 | 0.16 | 0.05 |
| Albumen weight | 0.91*** | 0.64*** | 0.77*** | 0.35*** | -0.03 | -0.21* | -0.13 |
| Albumen height | 0.15 | 0.17 | 0.04 | -0.06 | -0.23 | -0.17 | -0.14 |
| Albumen width | 0.29** | 0.11 | 0.27** | 0.42*** | 0.12 | 0.31*** | 0.08 |
| Albumen ratio | 0.21* | 0.24** | 0.14 | -0.33*** | -0.17 | -0.56*** | -0.14 |
| Haugh unit | 0.004 | 0.07 | -0.10 | -0.15 | -0.23 | -0.18 | 0.13 |

*: p<0.05; **: p<0.01; ***: p<0.001

expected, yolk height (1.77 cm) was greater than albumen height (0.86 cm) but the reverse was the case between yolk width and albumen width . On the other hand, the phenotypic correlation values related to the internal and external quality traits of the egg are shown in Table 2-4.

In this study (Table 2), the statistically non-significant but negative phenotypic correlation value (-0.09) determined between the egg weight and the shape index disagreed with the findings of Kul and Seker (2004) in quail eggs. They obtained significant but negative values. There was statistically significant phenotypic correlation ($p<0.001$) between egg weight and egg length (0.66), egg width (0.88) and shell weight (0.61) in the study. The egg weight has a direct relation with the shell quality of the egg. Shell weight indicated a positive significant phenotypic correlation with shell thickness (0.74), egg width (0.61) and egg length (0.27). Thus, shell weight has a direct relation with shell thickness, egg width and length. The phenotypic correlation value (0.05) obtained between the egg weight and shell thickness was low compared to 0.26 reported by Stadelman (1986). This implies that egg weight in this flock has a very weak association with eggshell thickness. Shell ratio in the total egg also has a low phenotypic correlation value (0.04) with egg weight. This case was most probably resulted from the fact that the increase in egg weight did not affect the proportion of the shell at the same rate it affected other components. It has been considered that the egg shell quality could be determined by using the egg weight values due to the positive and significant correlation ($p<0.001$) obtained between the egg weight and the shell weight. Similarly, Ozcelic (2002) reported that the egg weight values are 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. Statistically significant, respectively positive and negative correlation ($p<0.001$) was obtained between the shape index and the egg width and length. Similar results were reported in previous researches (Ozcelic, 2002; Kul and Seker, 2004). In this study, the positive significant phenotypic correlation value (0.82) between shell weight and shell ratio was consistent with the research findings of Kul and Seker (2004). There was positive, non-significant relation (0.12) between shape index and shell weight. Therefore, shell weight could not be considered a good estimator of egg shape index. Egg width was indicated to be a good estimator of shape index. In this study, shape index was not a good estimator for the shell thickness and the shell ratio. On the contrary, Yannakopoulos and Tserveni-Gousi (1986) reported that egg shape index could be used as a criterion for determining the stiffness of eggshell.

In this study (Table 3), statistically significant ($p<0.001$) negative correlation values of 0.62 and 0.27, respectively were found between the yolk weight, yolk width and albumen ratio among the internal quality traits of the egg, whereas, statistically significant ($p<0.00$) positive phenotypic correlation value (0.34) was found between yolk height and haugh unit. Statistically significant ($p<0.001$) negative phenotypic correlation values of 0.63 and 0.90, respectively were found between yolk ratio and albumen weight and ratio, whereas, statistically significant ($p<0.001$) positive phenotypic correlation values of 0.34 and 0.36, respectively were obtained between yolk height and albumen weight and height. Statistically significant ($p<0.001$) negative phenotypic value (0.41) was determined between albumen width and haugh unit, whereas, statistically significant ($p<0.05$) positive phenotypic correlation (0.21) was found between yolk width and albumen weight. Statistically significant positive correlation ($p<0.05$, $p<0.001$) was found between the albumen height and the haugh unit (0.97), albumen weight (0.19) and yolk height (0.36), whereas, statistically negative phenotypic correlation ($p<0.001$) was determined between the albumen height (0.35) and albumen width. Yolk weight had very important positive correlation ($p<0.05$, $p<0.001$) with all internal quality traits except albumen ratio. These results indicated that as the yolk weight increased, yolk width, height and ratio increased and the yolk quality got better. The improvement and significant positive correlation indicated amongst albumen indices which are the parameters (Ozcelik, 2002) giving us an idea about the dense albumen quality as well as being used for the estimation of the haugh unit which is one of the internal quality traits of the egg and an important criterion for determining the internal quality of the egg, implied that the value of the haugh unit increased as well. Similar to the results obtained in this study, Akbas *et al*. (1996) and Kul and Sekr (2004) reported statistically significant phenotypic correlation between the yolk height and the albumen height and haugh unit. Statistically significant ($p<0.001$) positive phenotypic correlation value (0.97) was determined between the albumen height and haugh unit. The result was similar to the findings of Akbas *et al*. (1996) and Ozcelik (2002) who both obtained 0.97 haugh unit. The negative correlation between yolk weight and albumen ratio was in agreement with the result of Kul and Seker (2004). Similarly, the negative but significant ($p<0.001$) correlation between albumen weight and yolk ratio was in conformity to their results.

In this study, the result of phenotypic correlation determined between the internal and external quality traits of the egg indicated that there was an increase in the egg weight and a decrease in yolk ratio and there was statistically significant increase in other traits ($p<0.05$, $p<0.01$, $p<0.001$) except for albumen height and haugh unit (Table 4). These results were in agreement with the research findings of Ozcelic (2002) and Kul and Seker (2004). Statistically important positive correlation was obtained between the eggshell weight and the internal quality traits, e.g., yolk weight (0.47), yolk height (0.19) yolk width (0.26) albumen weight (0.35) and albumen width (0.42) whereas, negative correlation value (0.33) was obtained between the shell weight and albumen ratio. As far as the eggshell ratio increased, statistically significant decreases occurred in internal quality traits except yolk weight and albumen width but the decreases in yolk height, albumen height and haugh unit were not considered statistically significant. The negative but significant correlation between the eggshell ratio and albumen weight and ratio was similar to the findings of Ozcelic (2002) and Kul and Seker (2004). In this study, there was negative but non-significant correlation between shell thickness and almost all internal egg quality traits.

According to the results obtained in this research, almost all internal quality traits of the egg were changed at the significant levels depending on the change which occurred in the egg weight with respect to the external quality traits of the egg. However, shell ratio changed inversely to albumen weight and ratio. Shape index was found negative non-significantly correlated with internal quality traits. Egg length and width indicated positive statistically significant ($p<0.01$, $p<0.001$) correlation with yolk weight, height and width and albumen weight, whereas they were statistically negatively correlated ($p<0.001$) with yolk ratio. The correlation value with the internal quality traits of the egg width was determined somewhat higher than the values obtained for egg length i.e., egg width has strong association with internal quality traits than egg length. This result has indicated that the egg width might be a good estimator of internal quality traits rather than the egg length. Similar results were obtained in other research findings (Ozcelic, 2002; Kul and Seker, 2004).

This study revealed that it is possible to use egg weight in determining egg length and width and shell weight while shell weight could be used to determine shell thickness and shell ratio. Egg weight therefore, is a good determinant of eggshell quality of exotic layer breeders. In addition, it was found that the internal quality traits of the egg changed at statistically significant levels, except for the haugh unit and albumen height depending on the changes in the egg weight, egg width and length. Furthermore, all other external quality traits had effects on the changes which occurred in some internal quality traits.

## REFERENCES


Akbas, Y., O. Altan and C. Kock, 1996. Effect of hens on external and internal egg quality traits. Turk. Veterinerlik-ve-Hayvancilik-Dergisi, 20: 455-460.

Altan, O., I. Oguz and Y. Akbas, 1998. Effects of selection for high body weight and age of hen on egg characteristics in Japanese Quail (*Cortunix cortunix japonica*). Turk. J. Vet. Anim. Sci., 22: 67-73.

Altinel, A., H. Gunep, T. Kirmizibayrak, S.G. Corekci and T. Bilal, 1996. The studies on egg quality characteristics of Japanese quails. J. Fac. Vet. Univ. Istanbul, 22: 203-213.

Choi, J.H., W.J. Kang, D.H. Baik and H.S. Park, 1983. A study on some characteristics of fractions and shell quality of the chicken egg. Korean J. Anim. Sci., 25: 651-655.

Hamilton, R.M.G., 1982. Methods and factors that affect the measurement of egg shell quality. Poult. Sci., 61: 2022-2039.

Hurnik, G.G., B.S. Renhart and J.F. Hurnik, 1978. Relationship between albumen quality and hatchability in fresh and stored hatching eggs. Poult. Sci., 57: 854-857.

Islam, M.A., S.M. Bulbul, G. Seeland and A.B. Islam, 2001. Egg quality of different chicken genotypes in summer and winter. Pak. J. Biol. Sci., 4: 1411-1414.

Kul, S. and I. Seker, 2004. Phenotypic correlations between some external and internal egg quality traits in the Japanese quail (*Cortunix cortunix japonica*). Int. J. Poult. Sci., 3: 400-405.

McDaniel, G.R., D.A. Roland and M.A. Coleman, 1978. The effect of egg shell quality on hatchability embryonic mortality. Poult. Sci., 58: 10-13.

Narahari, D., K. Abdul-Mujev, A. Thangavel, N. Ramamurty, S. Visunathan, B. Mohan, B. Murgananda and V. Sunrararosu, 1988. Traits influencing the hatching performance of Japanese quail eggs. Br. Poult. Sci., 29: 101-112.

Nordstrom, J.O. and L.E. Ousterhout, 1982. Estimating of shell weight and shell thickness from egg specific gravity and egg weight. Poult. Sci., 61: 1991-1995.

Oluyemi, J.A. and F.A. Roberts, 2000. Poultry Production in Warm Wet Climates. 2nd Edn., pp: 11-12, 50-52.

Ozcelic, M., 2002. The phenotypic correlations among some external and internal quality characteristics in Japanese quail eggs. Vet. J. Ankara Univ., 49: 67-72.

Peebles, E.D. and H.L. Marks, 1991. Effects of selection for growth and selection diet on egg shell quality and embryonic development in Japanese quail. Poult. Sci., 70: 1471-1480.

SAS (Statistical Analysis System), 2001. SAS Users Guides: Statistics. 8th Edn., SAS Institute Cary, NC, USA.

Snedecor, G.W. and W.G. Cochran, 1980. Statistical Method. 7th Edn., The Lowa State University Press, Ames, Lowa, USA.

Stadelman, W.J., 1986. The Preservation of Quality in Shell Eggs. In: Egg Science and Technology. Stadelman, W.J. and O.J. Cotteril (Eds.), Avi Publishing Com. Inc., Westpoint, Connecticut, USA.

Uluocak, A.N., F. Okan, E. Efe and H. Nacar, 1995. Bildircin yumurtalarinda bazi dis ve ic kalite ozellikleri ve bunlain yasa gore degisimi. Turk. J. Vet. Anim. Sci., 19: 181-185.

Yannakopoulos, A.L. and A.S. Tserveni-Gousi, 1986. Quality characteristics of quail eggs. Br. Poult. Sci., 27: 171-176.