Journal of Animal Research: v.6 n.2, p. 89-93. April 2016
DOI: 10.5958/2277-940X.2015.00173.4

Estimation and Analysis of Genetic Association Between Important External and Internal Egg Quality Traits in White Leghorns

Pradeepta Kumar Rath[1, 3*], Prasanna Kumar Mishra[1], Bandi Kumar Mallick[2], Nrusingha Charan Behura[1] and Pratikshya Panda[1]

[1]*P.G Department of Poultry Science, College of Veterinary Science and Animal Husbandry, OUAT, Odisha, INDIA*
[2]*Central Poultry Development Organisation, Eastern Region, Bhubaneswar, Odisha, INDIA*
[3]*Indian Veterinary Research Institute, Izatnagar, Bareilly, Uttar Pradesh, INDIA*

[*]*Corresponding Author: PK Rath; Email:pradeeptacuty@gmail.com*

Received: 17 October, 2015 **Accepted**: 29 February, 2016

ABSTRACT

Under this study, it has been aimed to determine the genetic correlations for different external and internal egg quality traits .The eggs were collected form 548 progenies (1 egg from each progeny) of 282 dams mated to 47 sires of a White Leghorn flock at Central Poultry Development Organization (CPDO), Eastern Region, Bhubaneswar, Government of India. Full-sib method of analysis was adopted to estimate the existing genetic correlations among different egg quality traits. Egg weight was found to have statistically significant ($p<0.01$), positive genetic correlations with shell weight (0.73), albumen weight (0.73), yolk weight (0.68), yolk height (0.51), yolk diameter (0.46) and yolk index (0.42). It was also determined that most of the internal quality traits of the egg changed at statistically significant levels ($p<0.01$) according to the changes in egg weight and egg breadth. Our studies show that if selection for albumen height will be operated, it will positively affect to internal and external traits whereas shape index will be affected negatively (-0.52 ± 0.14). It is feasible to formulate an index selection depending upon the magnitude of correlations between different quality traits for improvement of more than one traits at a time.

Keywords: White Leghorn, Genetic correlation, External egg quality traits, Internal egg quality traits

An egg contains all the essential amino acids for human and provides some important minerals and vitamins along with 163 calories of energy per 100g of edible content. It can assure about 13.3% of an adult's and nearly 25% of a child's daily requirements for protein (Grela *et al.* 2014). In previous decades, poultry breeders have achieved a commendable success in terms of egg production per hen due to their uninterrupted focus on selection for this trait. However, significant features of a good quality egg have always led the consumers to demand for some internal and external qualities in such product apart from the quantity demanded (Uluock *et al.* 1995). External and internal characters of an egg mainly depend upon the breed and its duration of storage (Tumova *et al.* 2007). External quality of an egg refers to shell cleanliness, soundness of shell, texture, colour, shape and size of the egg. Whereas, the internal quality refers to albumen and yolk parameters including relative viscosity of albumen, shape and firmness of yolk, strength of yolk, size of air cell and presence of blood or meat spots. The overall quality of eggs has been considered as the most important trait by both the producers and consumers, which calls for a continuous genetic evaluation of different egg quality traits in the present market scenario (Sreenivas *et al.* 2013). Profitability of egg production solely rely on different important egg qualities like shell associated quality traits (Khong *et al.* 2014). The breeders need to improve the genetic constitution of the existing flock and to further propagate the genetically superior germplasm (Gogoi and Mishra, 2013). To decide perfect selection criterion, it is crucial to know the correlated response between different quality traits.

Response in correlated traits refers to the associated change in an unselected trait, when selection is applied for the primary trait. The magnitude and direction of correlated responses to selection depends upon the 'correlation' between two traits which can be genetic, environmental or combination of these two (phenotypic). The theory of genetic correlation has been discussed in detail by Hazel (1943), Lerner (1950) and Falconer (I960). The genetic correlation between two traits may be due to linkage or pleiotropy. Linkage is transient in nature and breaks down when selection is conducted for several generations. Pleiotropy is the property of a gene where it affects two or more characters simultaneously and the resulting correlation is the overall net effect of all the segregating genes that affect both the traits. The coefficient of genetic correlation expresses the degree of association of breeding values between two traits and enables to predict the change in the correlated trait when selection is applied for another trait. In other words, it determines the response in correlated traits which help in deciding the selection criterion when simultaneous improvement in both the traits is desired.

In view of the above, present investigation was carried out in a White Leghorn flock with an objective to study 'the pattern of association between different external and internal quality traits of egg'. To achieve this degree of association, genetic correlations were estimated among different external and internal egg quality traits.

MATERIAL AND METHODS

Genetic stock and management

The data used for this study were collected from 548 progenies of 282 dams mated to 47 sires of a White Leghorn strain flock at Central Poultry Development Organization (CPDO), Eastern Region, Government of India. 1 egg from each progeny (Full-sib) was collected at 40 weeks of age and data were recorded on the same day of collection. The chicks, grower and layer birds were reared in floor pens and fed conventional starter, grower and layer rations respectively. A lighting schedule of 16 hours per day was applied during the laying period. Standard vaccination and medication measures were followed during the study period.

Egg quality traits and their estimation

For this study, six external and eight internal egg quality traits having utmost importance were been considered. The different external traits were egg weight (gm), egg breadth (mm), egg length (mm), shape index, shell thickness (mm) and shell weight (gm). Whereas the internal quality traits included albumen height (mm), haugh unit, albumen weight (gm), yolk height (mm), yolk diameter (mm), yolk weight (gm), albumen index and yolk index. Some of the traits were measured directly and the rest were estimated by using standard formulae given by esteemed previous researchers. Kul and Sekar (2004) have also reported the estimation of these parameters.

Statistical analysis

The linear statistical model used for the experiment was,

$$Y_{ijk} = \mu + S_i + d_{ij} + e_{ijk}$$

Where, Y_{ijk} - Observation of the kth progeny of the jth dam mated to the ith sire; μ-Over all mean of the population; S_i - effect of ith sire; d_{ij} = effect of jth dam mated to the ith sire; e_{ijk} = the random error associated with Y_{ijk}.

The Variance and covariance components were estimated using SPSS programming. Genetic and Phenotypic correlations between all the external and internal traits were derived from 'Sire+ dam' (full-sib) components of variances and covariance (Becker, 1967).

The genetic correlation between X and Y was calculated from 'sire+dam' (full-sib/S+D) components of variance ($\sigma^2_{s\ (x)}$, $\sigma^2_{S\ (x)}$) and covariance (COV_{XY}) as,

$$r_{G(S+D)} = \frac{COV_{S(XY)} + COV_{D(XY)}}{\sqrt{\left[\sigma^2_{S(X)} + \sigma^2_{D(X)}\right]\ \left[\sigma^2_{S(Y)} + \sigma^2_{D(Y)}\right]}}$$

The standard error of the genetic correlations was calculated by using the formula given by Robertson (1959).

$$\text{S.E. of } \left(r_G\right) = \frac{1-r^2_G}{\sqrt{2}}\sqrt{\frac{\text{S.E.}\left(h^2_X\right)\times \text{S.E.}\left(h^2_Y\right)}{h^2_X \times h^2_Y}}$$

Table 1. Genetic Correlations from 'sire+dam' (full-sib) components of variance and covariance between different external traits

	Egg weight	Egg breadth	Egg length	Shape index	Shell thickness
Egg breadth	0.53±0.15**				
Egg length	0.26±0.22	0.35±0.17**			
Shape index	0.02±0.20	0.27±0.22	0.51±0.14**		
Shell thickness	0.05±0.22	-0.26±0.17	0.07±0.20	0.04±0.21	
Shell weight	0.73±0.18**	0.02±0.33	-0.13±0.36	-0.02±0.37	0.14±0.34

**: P<0.01(values represent to the correlation between traits of corresponding rows and columns)

Table 2. Genetic Correlations from 'sire+dam' (full-sib) components of variance and covariance between different internal traits

	Albumen height	Haugh unit	Albumen weight	Yolk height	Yolk diameter	Yolk weight	Albumen index
Haugh unit	0.80±0.07**						
Albumen weight	0.53±0.12**	0.01±0.20					
Yolk height	0.45±0.12**	0.23±0.17	0.55±0.10**				
Yolk diameter	0.74±0.07**	0.01±0.20	0.08±0.16	0.54±0.10**			
Yolk weight	0.71±0.08**	-0.13±0.20	0.17±0.16	0.60±0.10**	0.12±0.17		
Albumen index	0.59±0.13**	0.76±0.10**	0.08±0.19	0.76±0.07**	0.38±0.17**	-0.01±0.20	
Yolk index	0.46±0.13**	0.19±0.20	0.48±0.13**	0.85±0.04**	-0.62±0.10**	-0.19±0.16	0.01±0.20

**: P<0.01(values represent to the correlation between traits of corresponding rows and columns)

RESULTS AND DISCUSSION

The genotypic correlations were estimated between all the internal and external egg quality traits considered under the study. Correlations obtained from analysis of variances and covariance, were presented in separate tables for external traits (Table 1), internal traits (Table 2) and in between these external and internal traits (Table 3). Discussions have been made for those egg quality traits that have moderate to strong correlations.

Egg weight has been critically observed with other external and internal traits as it is the easiest trait to measure and hence, can facilitate examining multiple traits when resources are limited. In the present study, the genetic correlation between egg weight and egg breadth was estimated as 0.53 ± 0.15 (Table 1). The values show a statistically significant positive correlation between these two traits. These findings strongly corroborates to the reports Abanikannda *et al.* 2007; Aygun and Yetisir, 2010. The Shell quality traits like shell weight and thickness were found to be statistically significant and highly correlated to the egg weight. The findings were in similar trend with the estimates of Yang and Dhaliwal. Hence, shell quality can be determined from egg weight only, instead of breaking eggs to measure thickness and weight of the shell. Egg weight was also observed to have a positive association with both albumen height and albumen weight and the values were comparable to reports (Yang *et al.* 2005; Baumgartner, 1994). However, egg weight is seen to have a negative genetic correlation (-0.22) with albumen index which contradicts to the reports of Laxmi *et al.* (2002).

A negative association was also found between egg weight and albumen height but due to non-availability of literature it was not possible to compare the result with others. Statistically significant and highly positive correlations were found between egg weight and yolk parameters (Table 3) which corroborates to the report by Baumgartner, 1994. The genetic correlations of egg weight with yolk height and yolk weight were estimated

Table 3. Genetic Correlations from 'sire+dam' components of variance and covariance between different external and internal quality traits

	Albumen height	Haugh unit	Albumen weight	Yolk height	Yolk diameter	Yolk weight	Albumen index	Yolk index
Egg weight	0.33±0.19	-0.05±0.25	0.73±0.09**	0.51±0.13**	0.46±0.16**	0.68±0.11**	-0.22±0.23	0.42±0.17**
Egg breadth	0.58±0.11**	-0.21±0.20	0.44±0.13**	-0.28±0.14	0.52±0.12**	0.30±0.16	0.45±0.16**	-0.08±0.17
Egg length	0.38±0.16**	-0.06±0.23	0.32±0.16	-0.05±0.17	-0.10±0.19	0.25±0.18	-0.11±0.22	-0.01±0.19
Shape index	-0.52±0.14**	0.05±0.23	0.15±0.18	0.06±0.17	0.06±0.19	0.18±0.19	0.16±0.22	0.02±0.20
Shell thickness	0.20±0.18	-0.01±0.22	0.01±0.18	-0.51±0.16	-0.10±0.18	0.07±0.18	0.08±0.21	0.01±0.18
Shell weight	0.50±0.24	-0.06±0.39	0.31±0.28	0.60±0.18**	0.13±0.32	0.32±0.29	0.26±0.35	-0.01±0.33

**: $P<0.01$(values represent to the correlation between traits of corresponding rows and columns)

as 0.51 ± 0.13 and 0.68 ± 0.11 respectively. Egg weight was also positively correlated to yolk diameter which is in agreement to the work (Meissner, 1972). The magnitude and direction of correlated response reported in the study indicates, improvement in egg weight will decrease the albumen index whereas the yolk index will be increased. Laxmi *et al.* (2002) found a positive genetic association for these traits but Kotaiah *et al.* (1975) did not find any correlation between these quality parameters. Hence, 'egg weight' can be used in determining the egg breadth, albumen weight, yolk weight, egg shell weight, yolk height and yolk diameter as all these traits were significantly correlated to egg weight both genetically and phenotypically.

Egg length and egg breadth were positively associated (0.35 ± 0.17) which confirms the earlier reports (Abanikannda *et al.* 2007; Olawumi and Ogunlade, 2008). However, a negative correlation was found between egg shape index and albumen height contradicting to the report (Yang *et al.* 2005).

The genetic correlation between albumen height and haugh unit was statistically significant and positive (Table 2), strengthening to the fact that, the haugh unit is a measure of albumen height. When albumen index is considered with other traits it has shown a significantly positive correlation between traits like albumen height, haugh unit, yolk height and yolk diameter which suggests that when selection will be done on the basis of albumen index, it will definitely enhance the correlated traits in positive manner. Yolk index has been reported to show an opposite trend in it's association with yolk diameter which is in agreement to the report by Kul and Sekar. However, the insignificant correlation found between yolk index and egg shell thickness controvert to the findings of Sharma *et al.* (2002) who reported a negative genetic but positive phenotypic correlation between these traits.

A negative correlation was estimated between egg length/ egg breadth and yolk height that contradicts to the earlier estimates (Olawumi and Ogunlade, 2008). Statistically significant and positive genotypic correlation (0.53 ± 0.12) was estimated between albumen height and albumen weight, a significant phenotypic association was earlier estimated (Kul and Sekar, 2004). Previously reported negative correlation between yolk height and shell thickness and positive correlation between yolk height and yolk diameter were supported by the present estimates (Olawumi and Ogunlade, 2008). Since genetic and phenotypic parameters are property of a population and vary depending upon the breeding history, variation in the results obtained in the present study cannot be entirely unanticipated.

CONCLUSION

It is concluded that, egg weight value can be used in assessing other egg quality parameters like weight of shell, albumen and yolk, yolk height, yolk diameter and yolk index. In addition, it was determined that most of the internal quality traits of the egg changed at statistically significant levels according to the changes in egg weight and egg breadth. If selection for albumen height will be operated it will affect positively the internal and external traits whereas shape index will be affected negatively at a significant level. Finally, depending upon the magnitude of correlations between different traits, an index selection can be taken up for improvement of more than one quality traits at a time.

ACKNOWLEDGEMENTS

This work was supported by Odisha University of Agriculture and Technology and Central Poultry Development Organisation, Bhubaneswar, Odisha, India.

REFERENCES

Abanikannda, O.T.F., Olutogun, O., Leigh, A.O. and Ajayi, L.A. 2007. Statistical modeling of egg weight and egg dimensions in commercial layers. *Int. J. Poultry Sci*., **6**(1): 59-63.

Aygun, A. and Yetisir, R. 2010. The relationships among egg quality characteristic of different hybrid layers to forced molting programs with and without feed withdrawal. *J. Anim. Vet. Adv.,* **9**: 710-715.

Baumgartner, J. 1994. Japanese quail production, breeding and genetics. *World's Poult. Sci. J.,* **50**: 227-35.

Becker, W.A. 1967. Manual of Quantitative Genetics. Third edition. Washington State University.

Dhaliwal, S.K., Chaudhary, M.L. and Brah, G.S. 2003. Genetic analysis of egg quality in selected and control lines of Japanese quails. *Indian J. Poult. Sci*., **38**(2): 89-95.

Falconer, D.S. 1960. Introduction to Quantitative Genetics. Oliver and Boyd. Ltd. Edinbarg, London.

Gogoi, S. and Mishra, P.K. 2013. Study of correlation between body weight and confirmation traits in coloured synthetic dam line broiler chicken at five weeks of age. *J. Anim. Res*., **3**(2): 141-145.

Grela, E.R., Ognik, K., Czech, A. and Matras, J. 2014. Quality assessment of eggs from laying hens fed a mixture with lucerne protein concentrate. *J. Anim. Feed Sci.*, **23**: 236–243

Hazel, L.N. 1943. The genetic basis for constructing selection indexes. *Genetics,* **28**: 476-490.

Khong, C., Sen, S., Lee, S., Choi, Y., Kim, K.Y., Ingale, S., Kwon, K. and Chae, B. 2014. Effect of sodium butyrate supplementation on Performance, egg quality and bacterial load in the excreta of laying hens. *J. Anim. Res*., **4**(1): 141-153.

Kotaiah, T., Ayyagari, V.B. and Mohapatra, S.C. 1975. Egg quality traits as affected by method of housing. *Indian J. Poult. Sci*., **10**(2): 78-84.

Kul, S. and Seker, I. 2004. Phenotypic correlations between some external and internal egg quality traits in the Japanese quail (*Coturnixcoturnix japonica*). *Int. J. Poultry Sci.,* **3**(6): 400-405.

Laxmi, P.J., Prasad, V.L.K., Murthy, A.S.R. and Reddy, C.E. 2002. Correlations among various egg quality traits in White Leghorn. *Indian Vet J.,* **79**(8): 810-813.

Lerner, I.M. 1950. Population Genetics and Animal Improvement. Cambridge University Press. London, England.

Meissner, E. 1972. Correlation between some egg quality characters in several broiler breeds. Mathematisch Naturwissenchaftheha Reihe, **21**(2): 161-166.

Olawumi, S.O. and Ogunlade, J.T. 2008. Phenotypic Correlations between some external and internal egg quality traits in the Exotic Isa Brown Layer Breeders. *Asian J. Poult. Sci*.,**2**: 30-35.

Robertson, A. 1959a. The sampling variance of the genetic correlation coefficient. *Biometrics,* **15**: 469–485.

Sharma, P.K., Verma, S.K. and Singh, B. 2002. Genetic parameters of production and egg quality character in White Leghorn. *Indian J. Poult. Sci.*, **37**(2): 181-182.

Sreenivas, D., Prakash, M.G., Mahendra, M. and Chatterjee, R.N. 2013. Genetic analysis of egg quality traits in White Leghorn chicken. *Vet. World,* **6**(5): 263-266.

Tumova, E., Zita, L., Hubeny, M., Skrivan, M. and Ledvinka, Z. 2007. The effect of oviposition time and genotype on egg quality characteristics in egg type hens. *Czech J. Animal Sci*., **52**: 26-30.

Uluocak, A.N., Okan, F., Efe, E. and Nacar, H. 1995. Bildircinyumurtalarindabazi dis veickaliteozelli klerive bunlarinyasa gore degisimi. Turk. *J. Vet. Animal Sci*., **19**: 181-185.

Yang, N., Zhang, L.C., Ning, Z.H., Xu, G.Y. and Hou, Z.C. 2005. Heritabilities and genetics and phenotypic correlations of egg quality traits in brown-egg dwarf layers. *Poult. Sci*., **84**(8): 1209-1213.