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Review Article

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Phenotypic Correlation Among Egg Quality Traits - A Review

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ABSTRACT

Growth of poultry industry depends both egg production and hatchability. For this a combination of poultry genetics and breeding is required along with others such as nutrition, health, housing etc Besides, an increase in the number of quality traits causes difficulties in the selection of parent stocks. Therefore, selecting the most determinative traits correlated with other traits facilitates in the selection of the breeds. This implies that egg quality traits can be improved genetically through knowledge of their genetic variability[8]. Phenotypic correlation is a measure of the strength (consistency, reliability) of the relationship between performance in one trait and in another trait. Thus a comprehensive overview of phenotypic correlation among various trait is needed. Egg weight found to be positively and significantly ($p<0.05, p<0.01$) correlated with most of the internal egg quality traits where as shape index found to be negatively correlated to most of the authors. Albumen height has positive and significant ($p<0.05$, $p<0.01$) correlation with albumen weight, yolk height, yolk weight and albumen index.

Key words: *Phenotypic correlation, Poultry, Egg weight, Egg quality traits*

INTRODUCTION

Poultry production in India has transformed from backyard farming to a vibrant organized industry during last 3 decades. Despite the fact India is today fourth largest producer of poultry meat in the world, but the per capita availability of poultry meat is only 2.15 kg as against 11kg recommended by the ICMR which necessitates need of huge growth of poultry industry. Correlations between characters seriously complicate the measurement of phenotypic selection, because selection on a particular trait produces not only a direct effect on the distribution of that trait in a population, but also produces indirect effects on the distribution of correlated characters. The problem of character correlations has been largely ignored in current methods for measuring natural selection on quantitative traits. This is obviously a tremendous oversimplification, since natural selection acts on many characters simultaneously and phenotypic correlations between traits are ubiquitous. Gihan and Ensaf[4], 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.

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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[13]. Phenotypic characteristic for egg quality traits of external and internal type is important mainly for interest of economy of production[9].

Phenotypic Correlation between the External Egg Quality Traits

The weight of the egg is the most important external quality trait of the egg influencing the weight of newly hatched chicks and hatching performance[3]. The existence of significant positive correlation between egg weight, shell weight and shell thickness has been reported by Farooq *et al*.[3]. This provides an indication for better prediction of egg shell weight and thickness from other quality traits[6].

Zita *et al*.[15], found that there was significant ($p<0.05$) and negative correlation between egg weight and shell thickness same as Udoh *et al*.[14], in Naked neck. However, they reported significant ($p<0.05$) negative correlation of egg weight and egg shell percentage. The authors have also reported positive and significant correlation between egg shell percentage and egg shell thickness.

Phenotypic correlation between external egg quality traits from five breeds of chicken presented by Islam and Dutta[5], revealed that there exist significant ($p<0.05$) and positive correlation between shell weight and shell ratio for all breeds. They also found a significant ($p<0.05$) and positive phenotypic correlation between egg weight and egg volume (egg length and egg width) for the Sonali breed.

Amankawah[2], reported significant ($p<0.01$, $p<0.05$) and positive correlation among different external egg quality traits except shape index and shell weight which were negatively correlated to egg length. Shell thickness and shell weight also reported to be negatively correlated with egg width.

Padhi *et al.*[12], found that in Vanaraja birds there was negative correlation between egg shape index and egg weight upto 52nd week of age and thereafter positively correlated. However, shell weight and shell thickness were reported to be positively correlated at all ages of measurement. Shell percent was reported to be negatively correlated at all ages of measurement except at 40th week of age.

Over all we see that egg weight have positive correlation with shell weight, shell thickness in most of the cases, egg length where as negative correlation with shape index. This suggest that eggshell quality can be determined through the egg weight. Duman et al., reported that egg weight has no significant correlation with shape index. Shape index is also negatively correlated to egg length, shell thickness and shell weight thus it is not a good determiner of eggshell quality.

Phenotypic Correlations between Internal Egg Quality Traits

Kul and Seker[7], reported significant negative correlation between the albumen height and the yolk ratio. They found statistically significant positive correlations between the albumen index and albumen height, albumen weight, haugh unit and yolk height. These indicate that an improvement of the albumen index will result in an improvement in albumen weight and the albumen ratio[11].

Olawumi and Ogunlade[10], observed highly significant ($p<0.01$) and positive correlation between yolk weight, yolk width, albumen weight and yolk height. However, negative correlation between yolk height, albumen height and albumen width was reported by the authors.

Islam and Dutta[5], reported that phenotypic correlation between yolk weight and albumen weight was direction less and non- significant between different breeds. Amankawah[2], found that all internal egg quality traits were significantly ($p<0.01$) and positively correlated between themselves except albumen weight which was negatively correlated with yolk width and yolk weight, and yolk index which was reported to be negatively correlated to yolk weight and yolk diameter.

Thus it is evident from the table 2. that Haugh unit found to be positively correlated to yolk index, albumen index and albumen height where as negatively correlated to yolk width, yolk ratio and albumen width as reported by most of the authors. It suggest that with the increase in yolk index and albumen height there will be increase in haugh unit which is one of the major determinant of internal egg quality traits. We can also see that albumen height has positive and significant ($p<0.05$, $p<0.01$) correlation with albumen weight, yolk height, yolk weight and albumen index, thus it can be suggested that breeding programme towards the improvement of albumen height can lead to over all improvement of internal egg quality traits.

Phenotypic Correlation between External and Internal Quality Traits

In laying flock of poultry it is very important to obtain a large number of eggs with normal structure, normal morphological composition and interior quality. These elements have very significant influence on biological value of the egg which determines normal development of the embryo. Weight of the egg albumen was predicted with accuracy from the egg weight, egg width and length due to significant correlation between them[6]. They were also able to predict with accuracy the weight of the yolk from the egg weight, length and width due to significant and positive correlation between them. However, a negative correlation value was obtained between shell weight and albumen ratio. There were no significant correlations between the shape index and internal quality traits with the exception of the albumen weight and yolk weight[10]. These findings were supported by Ozcelik [11], and Kul and Seker[7]. Oluwami and Ogunlade[10], also found that there was negative but non -significant correlation between shell thickness and almost all the internal quality traits of the egg. They also found that all the internal quality traits of the egg such as albumen height, albumen weight, yolk diameter, yolk height and yolk weight were significantly and positively correlated with egg weight in general.

Olawumi and Ogunlade[10], reported highly significant ($P<0.01$) and positive correlation between egg weight and yolk weight, yolk height, yolk width. Similarly albumen weight had highly significant ($P<0.01$) and positive correlation with egg weight, egg length, egg width and shell weight whereas non-significant correlation with shell thickness and shape index. Albumen height reported to be positively correlated with egg weight, egg length and egg width whereas negatively correlated with shell weight, shell thickness and shape index. However, these correlations were statistically non-significant. Albumen width had highly significant ($p<0.01$) and positive correlation with egg weight and shell weight.

Islam and Dutta[5] reported significant and positive phenotypic correlations between egg weight and yolk weight and between egg weight and albumen weight. They also reported negative but non-significant phenotypic correlation between egg weight and both albumen ratio and yolk ratio. Yolk weight and albumen weight were reported to be negatively correlated with the egg weight but it was statistically non-significant.

Padhi *et al*. [12],reported that in Vanaraja birds at different weeks of measurement there was positive correlation between egg weight and yolk index whereas albumen index showed positive correlation up to 52^{nd} weeks of age. Yolk weight, albumen weight and shell weight showed positive correlation with egg weight. The correlation of egg weight with albumen percent was reported to be higher than that with yolk and shell weight.

Alipanah *et al*.[1], reported positive correlation between egg weight, egg shell weight, egg width, egg length and yolk weight, albumen weight whereas negative correlation between shape index and yolk weight, albumen weight.

Amankawah reported significant ($P<0.05$) phenotypic correlation between internal and external egg quality traits in Cobb500. However, there were significant ($P<0.05$) positive correlations between egg weight and albumen weight, albumen height, albumen ratio, haugh unit, yolk diameter, yolk height, yolk weight, and yolk index. Almost all internal quality traits of the egg were reported to be correlated positively and significant ($p<0.05$). They also reported negative phenotypic correlation between the shell weight and albumen height, albumen weight and yolk ratio. Highly significant ($p<0.01$) but negative phenotypic correlation were reported between shape index and all the internal quality traits except yolk width and yolk diameter.

In this (Table 3) we found that egg weight found to be positively and significantly ($p<0.05$,$p<0.01$) correlated with most of the internal egg quality traits where as shape index found to be negatively correlated to most of them. Shell weight and shell thickness found to be negatively correlated to albumen weight, yolk weight and yolk index, it may be due to proportionate increase in albumen weight, yolk weight caused decrease in shell thickness and shell weight. Thus it may be suggested that for better hatchability there should be proper weightage given to both of the traits internal and external qualiy traits. Although egg weight found to be a good determinant of internal egg quality traits as well as egg shell qualities.

Table. 1. - The Phenotypic correlation coefficients between various external egg quality traits in pure and crossbred chicken as reported in the available literature

Traits	r_p	Reference
Egg weight x Egg shape/shape index		
Indigenous	-0.17	Islam and Dutta (2010)
Broiler	-0.21	,,
Fayoumi	-0.21	,,
RIR	-0.49	,,
Sonali	-0.05	,,
Egg weight x Shell weight		
Vanaraja at 28th wk	0.20	Padhi *et al* .(2013)
Vanaraja at 40th wk	0.44	,,
Vanaraja at 52nd wk	0.38	,,
Vanaraja at 64th wk	0.23	,,
Vanaraja at 72nd wk	0.55	,,
Egg weight x Shell thickness		
Brown egg layer strain(pooled)	-0.152	Zita *et al*.(2009)
Vanaraja at 28th week	0.02	Padhi *et al*.(2013)
At 40th week	0.25	,,
At 52nd week	0.27	,,
At 64th week	0.27	,,
At 72nd week	0.43	,,
Naked neck	-0.0236	Udoh et al.(2012)
Egg weight x Egg length		
Cobb500 broiler	0.468	Amankwah (2013)
Egg length x Shape Index		
Cobb500 broiler	-0.788	Amankwah (2013)
Egg length x Shell thickness		
Cobb500 broiler	0.028	Amankwah (2013)
Egg length x Shell weight		
Cobb500 broiler	-0.185	Amankwah (2013)
Egg width x Egg length		
Cobb500 broiler	0.407	Amankwah (2013)
Egg width x Shape index		
Cobb500 broiler	0.218	Amankwah (2013)
Egg width x Shell thickness		
Cobb500 broiler	-0.008	Amankwah (2013)
Egg width x Shell weight		
Cobb500 broiler	-0.135	Amankwah (2013)

Table.2.- The Phenotypic correlation coefficients among internal egg quality traits in pure and crossbred chicken as reported in the available literature

Traits	r_p	Refrences
Albumen Height x Albumen weight		
Japanese Quail	0.45	Kul and Seker(2004)
Cobb500 broiler	0.578	Amankwah (2013)
Albumen Height x Yolk Height		
Japanese Quail	0.30	Kul and Seker(2004)
Cobb500 broiler	0.684	Amankwah (2013)
Albumen Height x Haugh unit		
Japanese Quail	0.95	Kul and Seker(2004)
Albumen Height x Yolk Weight		
Japanese Quail	0.20	Kul andSeker(2004)
Albumen Height x Albumen Index		
Naked neck	0.206	Udoh et al.(2012)
Yolk weight x Albumen weight		
Indigenous	-0.31	Islam and Dutta (2010)
Broiler	0.20	,,
Fayoumi	-0.51	,,
RIR	0.65	,,
Sonali	-0.39	
Cobb500 broiler	-0.114	Amankwah (2013)
Naked neck	0.276	Udoh et al.(2012)
Yolk weight x Yolk width		
Naked neck	0.358	Udoh et al.(2012)
Haugh Unit x Yolk Diameter		
Japanese Quail	-0.09	Kul and Seker(2004)
Haugh Unit x Yolk Index		
Japanese Quail	0.23	Kul and Seker(2004)
Haugh Unit x Yolk Ratio		
Japanese Quail	-0.22	Kul and Seker(2004)
Haugh Unit x Albumen Index		
Japanese Quail	0.68	Kul and Seker(2004)
Naked neck	0.208	Udoh et al.(2012)
Haugh Unit x Albumen width		
Naked neck	-0.269	Udoh et al.(2012)
Haugh Unit x Albumen height		
Naked neck	0.934	Udoh et al.(2012)
Albumen index x Yolk Index		
Japanese Quail	.01	Kul and Seker(2004)
Yolk Index x Yolk Ratio		

Table. 3. -The Phenotypic correlation coefficients between external and internal egg quality traits in pure and crossbred chicken as reported in the available literature

Traits	r_p	Refrences
Egg weight x Albumen weight		
Exotic ISA Brown	0.91	Olawumi and Ogunlade(2008)
Cobb500 broiler	0.712	Amankwah (2013)
Naked neck	0.768	Udoh et al.(2012)
Egg weight x Albumen height		
Exotic ISA Brown	0.51	Olawumi and Ogunlade(2008)
Kazak layers	-0.03	Alipanah *et al.* (2013)
Cobb500 broiler	0.435	Amankwah (2013)
Egg weight x percent albumen		
Brown egg layer strain(pooled)	-0.039	Zita *et al* .(2009)
Egg weight x Yolk weight		
Naked neck	0.611	Udoh et al.(2012)
Cobb500 broiler	0.271	Amankwah (2013)
IWH Strain	0.768	Sreenivas *et al*.(2013)
IWI Strain	0.611	
IWK Strain	0.023	
Control Strain	0.578	
Egg weight x Yolk Height		
Exotic ISA Brown	0.45	Olawumi and Ogunlade (2008)
Cobb500 broiler	0.385	Amankwah (2013)
Egg weight x Yolk width		
Naked neck	0.373	Udoh et al.(2012)
Exotic ISA Brown	0.42	Olawumi and Ogunlade (2008)
Cobb500 broiler	0.299	Amankwah (2013)
Egg length x Albumen height		
Cobb500 broiler	0.364	Amankwah (2013)
Shape index x Albumen height		
Exotic ISA Brown	-0.14	Olawumi and Ogunlade(2008)
Kazak layers	0.05	Alipanah *et al*.(2013)
Cobb500 broiler	-0.264	Amankwah (2013)
Shape index x Albumen weight		
Indigenous	0.27	Islam and Dutta (2010)
Broiler	0.10	,,
Fayoumi	-0.15	,,
RIR	-0.44	,,
Sonali	-0.13	,,
Shape index x Yolk weight		
Kazak layer	-0.20	Alipanah *et al*.(2013)
Cobb500 broiler	0.009	Amankwah (2013)
Shape index x Yolk index		
Cobb500 broiler	-0.226	Amankwah (2013)

Shell thickness x Albumen height		
Exotic ISA Brown	-0.23	Olawumi and Ogunlade (2008)
Cobb500 broiler	0.030	Amankwah (2013)
Shell thicknes x Albumen weight		
Exotic ISA Brown	-0.03	Olawumi and Ogunlade(2008)
Naked neck	-0.266	Udoh et al.(2012)
Cobb500 broiler	-0.02	Amankwah (2013)
Shell thickness x Yolk weight		
Exotic ISA Brown	-0.09	Olawumi and Ogunlade(2008)
Naked neck	-.0243	Udoh et al.(2012)
Cobb500 broiler	0.003	Amankwah (2013)
IWH Strain	-0.035	Sreenivas *et al.*(2013)
IWI Strain	0.648	,,
IWK Strain	0.016	,,
Control Strain	0.096	,,
Shell thickness x Yolk index		
Cobb500 broiler	0.066	Amankwah (2013)
IWH Strain	-0.097	Sreenivas *et al.*(2013)
IWI Strain	0.037	,,
IWK Strain	-0.183	,,
Control Strain	-0.018	,,
Shell weight x Yolk index		
Cobb500 broiler	-0.178	Amankwah (2013)
Shell weight x Yolk weight		
Kazak layers	0.32	Alipanah *et al.*(2013)
Cobb500 broiler	-0.069	Amankwah (2013)
Shell weight x Albumen height		
Kazak layer	-0.11	Alipanah *et al.* (2013)
Cobb500 broiler	-0.236	Amankwah (2013)

CONCLUSION

The present study revealed good relationship among each other, thus simultaneous selection and improvement can be done. The study shows that egg weight can be the determinant of internal egg quality traits. In the same manner, albumen height, albumen index and yolk index recorded positive significant phenotypic correlations with Haugh unit score. The more the value, the more the quality of an egg while, less Haugh unit indicates less dense and poor interior egg qualities.

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