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Estimates of Phenotypic Correlation Between External and Internal Egg Quality Traits in Gramapriya, Vanaraja and their Crosses

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ABSTRACT

The present study was carried out with total of 211 eggs with more than 50 eggs from each genetic groups namely Gramapriya × Gramapriya (GP × GP), Vanaraja × Vanaraja (VR × VR), Vanaraja × Gramapriya (VR × GP) and Gramapriya × Vanaraja (GP × VR) to examine the phenotypic correlation between different egg quality traits in different genetic groups. The estimates of phenotypic correlation between egg weight and all the egg quality traits were highly significant ($P<0.01$), positive and very high in magnitude except the correlation with shape index and yolk index in the VR × GP genetic group. Also in GP × VR genetic group the estimates of phenotypic correlation between egg weight and all the egg quality traits were highly significant ($P<0.01$), positive and very high in magnitude except with yolk index and yolk height. Highly significant ($P<0.01$) correlations were observed among the various egg quality traits, except the correlation between egg length and shape index and between yolk width and yolk index where magnitudes were though high and significant but negative in direction. The estimate of correlation in VR × GP cross was positive in general, and highly significant in comparison to other genetic groups.

Keywords: Gramapriya, Vanaraja, Phenotypic correlation, egg quality traits

Poultry keeping in India was mostly a backyard system almost upto 1960s, and indigenous *desi* birds, though hardy and poor in productivity, were used for the production of eggs and meat. During the last five decades, the entire scenario of poultry farming in the country has been changed and the indigenous desi birds have gradually been replaced by highly specialised layers and broilers. Poultry farming evolved from subsistence farming to an integrated and highly commercial business oriented enterprise, the development of which was not only in size but also in productivity, sophistication and quality.

Although poultry farming emerged as an organised industry with tremendous employment opportunity and a potential tool to fight poverty and malnutrition, still lack in information regarding phenotypic and genotypic correlation of important economic traits which aid in selection and consequently improvement in traits. Ubani *et al*. (2010) reported that a pre-requisite of an appropriate breeding plan for genetic improvement of any stock is the knowledge of genetic parameter. For achieving the aforesaid aim a knowledge of the phenotypic association between external and internal quality traits will assist in selection of only those birds which produce good quality eggs and should be retained for future breeding purposes. Thus the present study is concerned with the improved varieties of chicken like Vanaraja and Gramapriya and their crosses. Vanaraja, a dual purpose and Gramapriya, a layer type improved varieties developed at PDP (Project Directorate on Poultry), Hyderabad. These bird have better adaptability to adverse conditions and better immunocompetence. These birds lay more number of eggs than native chickens and eggs are tinted brown in colour and heavier than native chicken eggs. Meagre research work has been conducted in India to exploit the internal and external egg parameters and their phenotypic association.

Therefore, this study was designed to find association between different economically important traits.

MATERIALS AND METHODS

Eggs of four genetic groups, consisting of two purebreds and two crossbreds of chicken, maintained at Institutional Livestock Farm Complex, Bihar Veterinary College, Patna on random mating, constituted the experimental materials for the present study. The four genetic groups were Grampriya and Vanaraja purebred and their crosses as GP♂ × GP ♀, VR♂ × VR♀, GP♂ × VR ♀ and VR ♂ × GP ♀. Total 6 males and 30 females were taken from each genetic group and maintained separately under deep litter system in a flock with a mating ratio of 1 Male : 5 Females during the experimental period. To study the genetic effect on egg weight and egg quality traits, a total of 211 eggs were collected at random at the rate of more than 50 eggs from each genetic group upto 32 weeks of age. During the entire period of experiment, the chicks were kept under uniform managemental conditions and standard poultry ration. Feed and water was provided *adlib* throughout the experimental period.

Measurement of traits

Egg Weight

The weight of eggs were taken with the help of electronic balance to the nearest of 0.01 g accuracy at the age of sexual maturity and at different weeks of age.

Egg Length and Width

The length and width of the measured with the help of Vanier Caliper to the nearest of 0.01 cm.

Shape Index

The shape index was calculated as the ratio of egg width to the egg length as given by Olawumi and Ogunlade (2008).

$$\text{Shape index} = \text{Egg Width/ Egg length} \times 100$$

Egg Shell Thickness

The shell was separated from the vitelline membrane and thickness was measured by Screw Gauge. The shell thickness was measured at three places, first at the broaden

Table 1: Estimates of Phenotypic correlation (r_p + SE) among external egg quality trait in different genetic groups

Traits	GP×GP	VR×VR	GP×VR	VR×GP
Egg weight × Egg length	0.651^{**}±0.108	0.577^{**}±0.114	0.043±0.138	0.863^{**}±0.070
× Egg Width	0.559^{**}±0.118	0.681^{**}±0.102	0.243±0.134	0.091±0.139
× Shape index	-0.065±0.108	0.368^{**}±0.130	0.182±0.136	-0.416^{**}±0.127
× Shell thickness	0.141±0.141	0.213±0.136	0.563^{**}±0.114	0.911^{**}±0.057
× Shell weight	0.109±0.142	-0.39^{**}±0.128	0.375^{**}±0.128	0.821^{**}±0.079
Egg length × Egg width	0.465^{**}±0.126	0.411^{**}±0.127	0.028±0.138	0.007±0.140
× Shape index	-0.506^{**}±0.123	-0.179±0.137	-0.77^{**}±0.088	-0.561^{**}±0.115
× Shell thickness	0.102±0.142	-0.092±0.139	0.247±0.134	0.803^{**}±0.083
× Shell weight	0.131±0.141	-0.183±0.137	0.475^{**}±0.122	0.710^{**}±0.098
Egg width × Shape index	0.443^{**}±0.128	0.823^{**}±0.079	0.659^{**}±0.104	0.824^{**}±0.079
× Shell thickness	0.237±0.138	0.026±0.139	0.295^{*}±0.132	0.060±0.139
× Shell weight	0.319^{*}±0.135	0.053±0.139	0.014±0.138	0.084±0.139
Shape index × Shell thickness	0.003±0.143	0.088±0.139	0.365^{**}±0.129	-0.507^{**}±0.120
× Shell weight	0.021±0.142	0.061±0.139	-0.342±0.130	-0.475±0.123
Shell thickness × Shell weight	0.632^{**}±0.110	0.656^{**}±0.105	0.667^{**}±0.103	0.828^{**}±0.078

*(P<0.05), **(P<0.01)

end, second at narrow end and third at the middle part of the body of the egg shell. The mean of these three measurements was considered as shell thickness of the egg.

Shell Weight and Percent Shell

For taking shell weight the vitelline membrane was separated from the egg shell then washed and kept for a period of 24 hrs after that, weight of egg shell was taken with the help of electronic balance with accuracy of 0.01 g. The percent egg shell was calculated as the ratio of shell weight to the total egg weight and expressed as percentage.

Albumen Height

The egg was broken on a perfectly leveled glass plate. The height of thick albumen was measured by Spherometer at the highest and lowest points of the albumen. The average of two measurements was taken as mean height.

Albumen Index

Albumen index was calculated by the following formula, given by Olawumi and Ogunlade (2008).

$$\text{Albumen index} = \text{Height of albumen} / \text{Width of albumen} \times 100$$

Albumen and Yolk Weight and Percentage

The egg albumen and yolk were separated with the help of spatula and poured in two clean beakers after cleaning the residual albumen from the shell and weighted by top pan sartorius balance with accuracy of 0.01g. The percent albumen was calculated as the ratio of albumen weight to the total egg weight and percent yolk was calculated as the ratio of yolk weight to the total egg weight and expressed as percentage.

Yolk Height

The yolk height was measured using the Spherometer. The height was taken at the highest point of egg yolk.

Yolk Index

Yolk index was calculated as per the formula given by Olawumi and Ogunlade (2008).

$$\text{Yolk index} = \text{Height of the yolk} / \text{Width of yolk} \times 100$$

Yolk height

Height is determined by Spherometer and width (diameter) of egg yolk was measured with the Vernier Calipers. The width was multiplied by 10 to convert it into millimeter and the average of three measurements was taken for each observation.

The phenotypic correlation values related to the internal and external quality traits of the egg are determined by the Pearson Correlation Analysis (Snedecor and Cochran, 1994).

RESULTS AND DISCUSSION

Phenotypic correlation between external egg quality traits

Positive, significant ($P<0.05$, $P<0.01$) and very high correlation was found between egg weight and egg length and egg width (Olawumi and Ogunlade, 2008; Amankwah, 2013) in all the genetic groups except in the VR x GP groups. In the present study significant and non-significant values ranging from high to low magnitudes of phenotypic correlation between egg weight and egg shape index were observed and in both the directions (Padhi *et al.*, 2013). However, contrary to this findings a negative and significant correlation were found by (Sarica *et al.*, 2012; Amankwah, 2013). It might be due to different breed and managemental conditions.

Mostly significant and positive correlations of egg weight with shell thickness and shell weight was observed (Kumar, 2000; Alipanah *et al.*, 2012). Egg length was found to be positively significant ($P<0.05$) in both the direction in most of the correlation with all the egg quality traits in all the genetic groups except with the shape index where correlations were in negative directions indicating that egg length may be increased by considering shape index as the selection criterion. Highly significant and negative correlation between egg length and shape index has been reported by Amankwah (2013). Highly significant ($P<0.01$) and positive correlations between egg length and egg width was reported by Kumar (2000) similar to the present study. Egg width was found to have highly significant ($P<0.01$) and positive correlation with

Table 2: Estimates of Phenotypic correlation ($r_p \pm$ SE) between external and internal egg quality traits in different genetic groups

Traits	GP×GP	VR×VR	GP×VR	VR×GP
Egg weight × Alb. height	0.708**±0.100	0.157±0.138	0.243±0.134	0.656**±0.105
× Alb. weight	0.972**±0.033	0.972**±0.032	0.816**±0.080	0.899**±0.061
× Alb. index	0.007±0.142	0.192±0.137	0.104±0.137	0.500**±0.121
× Yolk height	-0.060±0.142	-0.52**±0.119	-0.503**±0.119	0.866**±0.070
× Yolk weight	0.580**±0.116	0.893**±0.063	0.817**±0.079	0.800**±0.084
× Yolk width	0.541±0.120	0.489±0.122	0.491±0.120	0.835±0.077
× Yolk index	-0.377±0.132	-0.306±0.133	-0.596±0.111	-0.222±0.136
Egg width × Alb. height	0.466**±0.126	0.281**±0.134	0.003±0.138	0.632**±0.108
× Alb. weight	0.572**±0.117	0.508**±0.120	0.243±0.134	0.804**±0.083
× Alb. index	0.148±0.141	0.011±0.140	0.006±0.138	0.467**±0.123
× Yolk height	-0.030±0.142-	-0.338*±0.131	0.619**±0.108	0.720**±0.097
× Yolk weight	0.656**±0.107	0.588**±0.113	-0.334*±0.130	0.616**±0.110
× Yolk width	0.250±0.138	-0.344*±0.131	-0.085±0.138	0.661**±0.105
× Yolk index	-0.208±0.139	-0.191±0.137	0.525**±0.118	-0.127±0.138
Egg length × Alb. height	0.582**±0.116	-0.109±0.139	0.009±0.138	0.055±0.139
× Alb. weight	0.572**±0.117	0.643**±0.107	0.176±0.136	-0.017±0.140
× Alb. index	0.148±0.141	0.237±0.136	-0.076±0.138	0.189±0.137
× Yolk height	0.198±0.140	-0.158±0.138	-0.172±0.136	0.115±0.139
× Yolk weight	0.263±0.137	0.550**±0.116	0.198±0.135	0.027±0.139
× Yolk width	0.208±0.139	0.589**±0.113	0.346*±0.130	0.119±0.092
× Yolk index	-0.036±0.142	-0.042±0.139	-0.256±0.134	-0.127±0.138
Shape index × Alb. height	0.004±.0.142	0.055±0.139	0.003±0.138	-0.407**±0.128
× Alb. weight	-0.015±0.142	0.370**±0.130	-0.071±0.138	-0.472**±0.123
× Alb. index	-0.253±0.138	0.244±0.136	0.048±0.138	-0.421**±0.127
× Yolk height	0.113±0.141	0.045±0.139	-0.571**±0.114	-0.313**±0.133
× Yolk weight	-0.339*±0.134	0.223±0.137	0.370**±0.129	-0.330*±0.132
× Yolk width	-0.094±0.143	-0.049±0.140	0.152±0.137	-0.280*±0.135
× Yolk index	0.129±0.142	0.077±0.140	-0.553*±0.116	0.063±0.140
Shell thickness × Alb. height	0.221±0.139	0.118±0.139	0.145±0.137	0.654**±0.105
× Alb. weight	0.025±0.142	-0.221±0.136	0.162±0.136	0.852**±0.073
× Alb. index	-0.232±0.139	-0.219±0.137	0.103±0.138	0.552**±0.117
× Yolk height	0.438±0.129	0.663**±0.104	-0.613±0.109	0.815**±0.081
× Yolk weight	0.082±0.143	-0.41**±0.128	0.775±0.087	0.740**±0.094
× Yolk width	-0.134±0.142	0.446**±0.125	0.580±0.113	0.843**±0.075
× Yolk index	0.386**±0.131	0.500**±0.121	-0.721**±0.096	-0.311*±0.133
Shell weight × Alb. height	0.332*±0.135	0.205±0.137	-0.268*±0.133	0.515*±0.120
× Alb. weight	-0.081±0.142	-0.456±0.125	0.045±0.138	0.713**±0.098
Shell weight × Alb. index	-0.265±0.138	-0.216±0.137	-0.316*±0.131	0.423**±0.127
× Yolk height	0.456**±0.128	0.809**±0.082	0.766**±0.089	0.762**±0.090
× Yolk weight	0.100±0.142	-0.58**±0.114	-0.736**±0.093	0.617**±0.110
× Yolk width	-0.216±0.138	0.469**±0.123	-0.207±0.136	0.817**±0.080
× Yolk index	0.458**±0.127	0.657**±0.106	0.743**±0.092	-0.337*±0.132

*(P<0.05), **(P<0.01)

shape index, shell thickness and shell weight in all the genetic groups (Amankwah, 2013) The coefficient of correlation between shape index and other egg quality traits were found to be either positive or negative and significant ($p<0.05$) or non-significant in all the genetic groups except in crosses between VR × GP where all the estimate were negative and significant ($P<0.05$) (Olawumi and Ogunlade, 2008; Amankwah, 2013). Shell thickness was found to have highly significant ($P<0.01$) and positive correlation coefficients with shell weight in all the genetic groups (Olawumi and Ogunlade, 2008)

Phenotypic correlation between external and internal egg quality traits

The estimates of coefficient of correlation between egg weight and other internal egg quality traits were found to be mostly positive, in general, highly significant ($P<0.01$) and moderate to very high in magnitude in all the genetic groups except the correlation of egg weight with yolk width and yolk index. The correlation between egg weight and albumen index was mostly non-significant except in VR × GP where values were found to be positive and significantly ($P<0.05$) very high in magnitude. Sreenivas *et al*. (2013) observed positive values for egg weight and albumen index in White Leghorn strains whereas negative correlation between egg weight and albumen index was observed by Sarica *et al.* (2012). Highly significant and positive correlations of high order between egg weight and albumen weight was observed (Olawumi and Ogunlade, 2008; Alipanah *et al.,* 2012; Amankwah, 2013). The phenotypic correlations between egg weight and yolk indices were found to be moderate in magnitude and non-significant, in general, but negative in the directions (Sreenivas *et al.*, 2013; Debnath and Ghosh, 2015). The present study indicates that as the weight of the egg increases, the albumen weight, albumin height, yolk weight and yolk height also increase. However the increase in weight of the albumen overshadows that of the weight of the yolk, the yolk ratio then decreases with an increase in the weight of the egg.

Highly significant ($P<0.01$) and positive correlations of egg length with egg width was observed. Egg length was found to have negative correlation with yolk indices in GP × GP, VR × VR and GP × VR where as positive and highly significant ($P<0.01$) correlation was observed in GP × VR (Bobbo *et al*., 2013). The magnitudes of correlation between egg length and internal egg quality traits were observed to be low to moderate and high in magnitude except the correlation of egg length with albumen index which was low and non-significant, in general, except highly positive and significant correlation in GP × GP (Bobbo *et al*., 2013). The review on correlation of egg length with albumen quality and yolk quality characteristics observed in the literature of Amankwah (2013) where it was found to be high in magnitude and positive similar to the findings of present study. The presence of highly significant ($P<0.01$) and positive correlations with high magnitudes in all the genetic groups revealed that albumen weight and yolk weight may be improved simultaneously by considering the egg length as a selection criterion.

Egg width was found to have highly significant ($P<0.01$) and positive correlation with yolk weight and yolk width in all the genetic groups. But the correlation of egg width with yolk indices was non-significant, negative and of very low in magnitude similar to the findings of Kumar (2000). Amankwah (2013) reported positive and significant correlation of egg width with albumen weight, yolk weight and yolk width which were similar to the findings of present study but contrary to the findings of correlation with yolk indices which was positive. Egg width was found to be positively correlated with albumen indices except in the GP × VR and negatively correlated with yolk indices but magnitudes of correlation were very low, in general.

The coefficient of correlation between shape index and other internal egg quality traits were found to be either positive or negative and significant ($p<0.05$) or non-significant in all the genetic groups except in crosses between VR × GP where all the estimates were negative and significant ($P<0.05$) similar to the findings of Kumar (2000). However, the magnitudes of correlation were estimated to be ranged from moderate to very low. Sarica *et al*. (2012) reported positive correlation of shape index with other egg quality traits where as Debnath and Ghosh, (2015) and Amankwah (2013) reported negative and significant correlation.

The estimates of correlation among shell thickness and internal traits were either positive or negative varied from moderate to very high in magnitude except VR × GP where correlation were observed to be highly significant

Table 3: Estimates of Phenotypic correlation (r_p ± SE) among internal egg quality traits of different genetic groups

Traits	GP×GP	VR×VR	GP×VR	VR×GP
Alb. height × Alb. weight	0.646**±0.126	0.125±0.139	0.198±0.135	0.673**±0.103
× Alb. index	0.164±0.141	0.495**±0.122	0.248±0.134	0.836**±0.076
× Yolk height	0.064±0.142	0.356**±0.130	-0.256±0.134	0.664**±0.127
× Yolk weight	0.384**±0.132	-0.250±0.136	0.230±0.134	0.408**±0.128
× Yolk width	0.527**±0.121	0.318*±0.132	-0.045±0.138	0.671**±0.104
× Yolk index	-0.227±0.139	0.209±0.136	-0.215±0.135	-0.233±0.136
Alb. Weight × Alb.index	0.018±0.142	0.261±0.135	-0.123±0.137	0.515**±0.120
× Yolk height	-0.134±0.141	-0.520**±0.11	-0.036±0.138	0.759**±0.091
× Yolk weight	0.439**±0.128	0.807**±0.082	0.341*±0.130	0.650**±0.106
× Yolk width	0.606**±0.113	0.510**±0.120	0.302*±0.132	0.716**±0.097
× Yolk index	-0.467**±0.12	-0.289*±0.134	-0.123±0.137	-0.170±0.138
Alb. index × Yolk height	-0.153±0.141	-0.129±0.139	-0.090±0.138	0.547**±0.117
× Yolk weight	0.128±0.141	0.104±0.139	0.177±0.137	0.326*±0.132
× Yolk width	0.199±0.140	-0.157±0.138	-0.100±0.137	0.590±0.113
× Yolk index	-0.232±0.138	-0.043±0.139	-0.047±0.138	-0.268±0.134
Yolk height × Yolk weight	-0.083±0.142	0.696**±0.100	-0.808**±0.081	0.649**±0.106
× Yolk width	0.395**±0.131	0.589**±0.113	-0.223±0.135	0.753**±0.092
× Yolk index	0.755**±0.093	0.799**±0.084	0.956**±0.040	0.045±0.139
Yolk weight × Yolk width	0.192±0.043	-0.495**±0.04	0.482**±0.50	0.668**±0.85
× Yolk index	-0.166±0.113	-0.518**±0.12	-0.856**±0.131	-0.226±0.112
Yolk width x Yolk index	-0.784±0.088	-0.518±0.119	-0.498**±0.120	-0.621**±0.109

*(P<0.05), **(P<0.01)

(p<0.01) and positive. Shell thickness was also observed to have positive correlation with other egg quality traits like albumen height , but correlations with yolk weight, albumen weight, albumen index, yolk height and yolk index were in both the directions (Sreenivas *et al.,* 2013; Debnath and Ghosh, 2015). However, the estimates of correlation of shell thickness with these traits were low and non-significant except in VR × GP where correlations were significant and moderate in magnitude. Amankawah (2013) observed negative correlation of shell thickness with albumen height and positive correlation with yolk index, yolk height, yolk weight and albumen height where as Olawumi and Ogunlade (2008) found negative and non significant correlation with other egg quality traits except albumen width.

Shell weight was found to have highly significant (P<0.01) negative correlations with albumen index, yolk weight and yolk width in all the genetic groups except correlation with yolk height and yolk index where it was highly significant and positive similar to the findings of Olawumi and Ogunlade (2008) and Sreenivas *et al*. (2013). The estimates of correlation was highly significant (P<0.01) and positive between shell weight and other egg quality traits in VR × GP but very high correlation of shell weight with albumen weight suggested that increased albumen weight may be associated with higher shell weight.

Phenotypic correlation between internal egg quality traits

The estimates of correlation between albumen height and other egg quality traits were found to have either significant (p<0.01) or non-significant but in both the directions among all the genetic groups except in VR × GP. The magnitudes of correlation with yolk indices were very low and non-significant indicating that albumen height had no definite role with the increase or decrease of yolk index similar to the findings of Kumar (2000) whereas Amankawah (2013) reported highly positive correlation with albumen height and yolk indices. The correlation between albumen height with yolk height and yolk width were found to be positive, very high in magnitude and highly significant (P<0.05) in all genetic groups, except in GP × VR where it was low and non-significant. The presence of highly significant (P<0.01) and positive correlations of albumen height with albumen weight and yolk weight in all the genetic groups, except in VR × VR, may suggest that by increasing the albumen height the correlated traits like albumen weight and yolk weight may be increased. The estimates of correlation between albumen height and albumen indices were found to be ranged from moderate to very high in magnitude which suggested that eggs had better albumen quality. The findings of the present study are in close agreement with the results of Kumar (2000) who reported highly significant correlation between albumen height and albumen index.

Albumen weight was found to have highly significant (P<0.01) and positive correlations in general, with yolk weight and yolk width in all the genetic groups similar to the findings of Kul and Seker (2004), Olawumi and Ogunlade (2008), Alipanah *et al*. (2012) and Sreenivas *et al*. (2013). Non-significant, in general, and very low magnitudes of correlation were observed in both the directions between albumen weight and albumen index similar to the findings of Kumar (2000) and Sreenivas *et al.* (2013) except in VR × GP group where finding was positive and significant. The correlation between albumen weight and yolk index was found to be negative and non-significant in all the genetic groups.

The coefficients of correlation between albumen index and various yolk quality traits were found to be non-significant, in general, except the correlations of albumen index with yolk weight, yolk width and yolk height in VR × GP group where it was correlated significantly (p<0.05). The magnitudes of correlation were found to be very low and in both the direction. Negative correlation coefficients found between albumen index and yolk index found in the present study was similar to the findings of Sreenivas *et al*. (2013). The reports on correlations between albumen index and other yolk quality traits could not be observed in the available literature.

Yolk height was found to have mostly positive and significant (P<0.05) correlation, in general, with other egg quality traits in all the genetic groups (Debnath and Ghosh, 2015). In VR × GP the correlation between yolk height and yolk width was highly significant (P<0.01) and positive in direction. These observations indicated that greater diameter of yolk leads to increased yolk weight. The estimates of correlation were observed to be varied from moderate to very high in magnitude indicating that yolk height may be used as selection criterion for the improvement of correlated trait like yolk index. Amankwah (2013) also reported highly significant and very high magnitudes of correlation between yolk height and yolk index. Positive and significant correlation coefficients were obtained between yolk height and yolk weight in VR × GP crossbreds.

Highly significant (P<0.01), negative and very high magnitudes of correlation were observed between yolk weight and yolk indices in all the genetic groups, however, the estimates of correlation between yolk weight and yolk width were low to high in magnitude and significant, in general, and in both the direction. The reports on correlation between yolk weight and yolk width, and between yolk weight and yolk index were scanty, however, Sreenivas *et al*. (2013) reported very low magnitude of correlation (-0.074 to 0.077) in different strains of White Leghorn, but the results obtained by Amankwah (2013) was similar to the findings of present study for correlation between yolk width and weight. However, the highly significant and negative correlation between yolk weight and yolk indices as observed in the present study, suggested that by decreasing the yolk diameter as positive correlation with yolk indices through selection the correlated trait yolk weight may be reduced as very large yolk size is not desirable from human health point of view.

Yolk width was found to have highly significant (P<0.01) and negative correlation with yolk index in all the genetic groups and magnitudes were moderate to high which suggested that yolk index may be increased or decreased by decreasing or increasing the yolk width but higher yolk index is the indication of good yolk quality. Similar result has been reported by Amankwah (2013) but the magnitude was lower than the values observed in the present experiment.

CONCLUSION

Results in present study suggest significant correlations and inter-linking among various egg quality traits. It showed strong relationship among pure and crossbred with some variation. All the genetic groups showed great similarities in the association between egg weight and other egg quality traits. The differences that exist in certain association in the four genetic groups suggest certain genetic polymorphism.

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