



Genetic impact on external and internal egg quality traits of Vanaraja and Gramapriya birds and their crosses in Bihar

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ABSTRACT

Poultry farming is gaining strength in mitigating livelihood and nutritional security to the poor farmers which constitute 60% of the India's population. Thus eggs of superior quality is prerequisite for profitable marketing and for hatchability too. The present study was conducted on two improved varieties, Vanaraja (dual purpose type) and Gramapriya (the layer type) chicken developed at PDP, Hyderabad and their crosses on random mating. The genetic groups taken were Gramapriya (male) x Gramapriya (female), Vanaraja (male) x Vanaraja (female), Gramapriya (male) x Vanaraja (female) and Vanaraja (male) x Gramapriya (female). 6 males and 30 females were taken from each genetic group and maintained separately under deep litter system with a mating ratio of 1 male : 5 females. To study the genetic effect on external and internal egg quality traits, a total of more than 50 eggs were collected at random from each of 4 genetic groups upto 28 weeks of age. The average shell thickness obtained to be ranged from 0.36 to 0.39 mm. The average albumen and yolk indices were found to be ranged from 7.396 to 8.656 and 41.749 to 43.888 respectively. The average shell weight and percentage of shell weight observed to be ranged from 4.147 to 5.627 g and 17.266 to 18.003% respectively.

Key words: Gramapriya, Egg quality traits, External, Internal, Vanaraja and their crosses.

INTRODUCTION

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decades, the entire scenario of poultry farming in the country has changed and the indigenous desi birds have gradually been replaced by highly specialised layers and broiler. According to Livestock Census (2012), India ranks 5th in poultry meat production and 3rd in egg production. The egg production in India during 2011-12 estimated to be 66 billion. The egg production has increased tremendously yet per capita availability of egg in India is 55 eggs/head/annum against the minimum nutritional requirement according to ICMR which is only 180 egg/head/annum to maintain normal health. According to Bihar Basic Animal Husbandry Statistics 2012, poultry population of Bihar estimated to be 14 million and ranked 6th among other states of India. In egg production its rank is 15th and in per capita availability of eggs it is 26th in position and only 8 eggs/head/annum is available whereas Andhra Pradesh and Tamilnadu are leading in egg production. Therefore Bihar is an egg deficient state and there is great need to increase egg production to cope up with its increasing demand with rapid growth in human population. The number of eggs produced should not be the only criteria but, due emphasis should also be given to the egg weight and other egg quality

traits for making poultry industry profitable. Stadelman (1995) described egg quality as the characteristics of an egg that affects its acceptability to the consumers. But egg quality traits are greatly influenced by the factors like breed, strain, variety, temperature, relative humidity, rearing practices and season (Washburn, 1990). Thus to bridge the gap between demand and supply the improved varieties which are lookalike indigenous chicken are now being massively introduced to encourage rural poultry production. Poultry farming promises a great scope to mitigate the challenges of poverty alleviation and as livelihood for poor and landless farmers. With this context the present study was conducted to compare the genetic effect on egg quality traits of Vanaraja and Gramapriya birds and their crosses. Vanaraja and Gramapriya are improved varieties of chicken developed at PDP, Hyderabad.

MATERIALS AND METHODS

To estimate the genetic effect on egg quality traits, eggs of four genetic groups, consisting of two purebreds and two crossbreds of chicken, namely Vanaraja (dual purpose type) and Gramapriya (the layer type) chicken developed at PDP, Hyderabad and their crosses on random mating. Thus, the genetic groups taken were Gramapriya x Gramapriya (GPxGP), Vanaraja x Vanaraja (VR x VR), Gramapriya x Vanaraja (GP x VR) and Vanaraja x Gramapriya (VR x GP),

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maintained at Institutional Livestock farm complex, Bihar Veterinary College, Patna on random mating. 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 > 50 eggs from each genetic group at 24 and 28 weeks of age. Egg weight and body weight were also taken at the age of sexual maturity. The eggs were weighed with the help of electronic balance to the nearest of 0.01 g. Eggs from each genetic group were collected at 24 weeks and at 28 weeks of age to record the egg weight.

During the entire period of experiment, the birds were kept under uniform managerial conditions and fed with standard poultry ration. Feed and water was provided *ad libitum* throughout the experimental period.

Measurements of traits

Egg weight : The weight of eggs was 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 Vernier 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).

Shape index = Egg Width / Egg length x 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 broader 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 per cent 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). Albumen index = Height of albumen/ Width of albumen x 100

Haugh unit (H.U.): Haugh unit was calculated by using the formula, given by Haugh(1937)

$H.U. = 100 \log (H + 7.57 - 1.7W^{37})$ Where, H is albumen height in millimeters, measured by spherometer and W is observed weight of the egg in grams.

Albumen, 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).

Yolk index = Height of the yolk/ Width of yolk x 100

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.

Statistical analysis: Data were analyzed by Mixed model least-square and maximum likelihood computer program pc-2 in the Department of Animal Genetics and Breeding, Bihar Veterinary College, Patna-14. The least squares means and standard error were calculated through least squares models (Harvey,1990) and some of the minor calculations were carried out by a programmable scientific calculator CASIO_{fx-100s} as per standard statistical method (Snedecor and Cochran,1994). Significant differences between means were tested by Duncan multiple range test (1955) and modified by Kramer, (1957). To observe the effect of genetic group factor on the aforesaid traits the following mathematical model was used:

$$Y_{ij} = \mu + G_i + e_{ij}$$

Where,

Y_{ij} is the measurement of a trait on the j^{th} bird of i^{th} genetic group

μ is the overall population mean

G_i is the effect of i^{th} genetic group

e_{ij} is the random error assumed to be normally and

independently distributed with mean 0 and variance NID $(0, \sigma_e^2)$.

RESULTS AND DISCUSSION

Genetic effect on external egg quality traits : The average egg weight at ASM, 24 weeks and 28 weeks of age are presented in Table 1. The analysis of variance for the genetic effect on egg weight revealed highly significant ($P < 0.01$)

Table 1: Least square mean and SE of external egg quality traits.

Traits	Genetic groups			
	GP x GP(51)	VR x VR(53)	GP x VR(54)	VR x GP(53)
Egg wt at ASM	35.62 ^a ± 0.263	39.94 ^b ± 0.447	45.75 ^c ± 0.250	43.62 ^d ± 0.205
Egg wt at 24 th wk	45.03 ^a ± 0.180	45.51 ^a ± 0.180	57.73 ^b ± 0.176	48.87 ^c ± 0.180
Egg wt at 28 th wk	47.59 ^a ± 0.324	47.71 ^a ± 0.386	59.5 ^b ± 0.345	51.62 ^c ± 0.293
Egg Length	51.66 ^a ± 0.150	52.04 ^a ± 0.147	53.70 ^b ± 0.146	54.36 ^c ± 0.147
Egg Width	40.10 ^a ± 0.161	40.29 ^a ± 0.158	44.30 ^b ± 0.156	41.97 ^c ± 0.158
Shape Index	77.719 ^a ± 0.343	77.41 ^a ± 0.337	82.51 ^b ± 0.333	77.27 ^a ± 0.337
Shell Thickness	0.37 ^a ± 0.002	0.36 ^b ± 0.002	0.39 ^c ± 0.002	0.39 ^c ± 0.002
Percent Shell	17.925 ^a ± 0.009(9.5)	17.266 ^b ± 0.009(8.8)	18.003 ^c ± 0.009(9.6)	17.898 ^a ± 0.009(9.4)
Shell Weight	4.458 ^a ± 0.037	4.147 ^b ± 0.036	5.627 ^c ± 0.036	4.783 ^d ± 0.036

NB- 1.Values present within the parentheses indicating actual percentage.

2. Means with similar superscripts (row wise-abc) did not differ significantly (P<0.05)

effect of breeds. The effect of breed and strain differences on egg weight in chicken as observed by many workers (Zita *et al.*, 2009; Islam and Dutta, 2010 and Mohanty and Nayak, 2011) were similar to the findings of the present investigation. In an experiment Niranjana *et al.* (2008) observed significant breed differences for egg weight over ages and reported that the egg weight of improved varieties i.e. Gramapriya and Vanaraja were similar to the findings of the present study. Egg weight of crossbreds found in present study at 28th week of age is comparable to the egg weight obtained by Jha and Prasad (2013) and Haunshi *et al.* (2009) at 40 weeks of age for Vanaraja and Gramapriya pure. The egg weight obtained by Mohanty and Nayak (2011) for Local Germplasm Vanaraja at 25th week of age was found to be lower than the present study.

The average estimates of egg length, egg width and egg shape index are presented in (Table.1). The analysis of variance revealed significant (P<0.01) effect of genetic group on egg length. The significant effect of breed on egg length has been reported by Niranjana *et al.* (2008). Significant differences of Crossbreds from purebreds have been reported by Islam and Dutta (2010). The analysis of variance revealed significant (P<0.01) differences for egg width between the genetic groups. Among the crossbreds GP x VR laid significantly (P<0.05) wider eggs than the purebreds and VR x GP crossbred. Both the crosses laid significantly (P<0.05) wider eggs than the purebreds. The results obtained in the present study are in accordance with the findings of Niranjana *et al.* (2008) and Islam and Dutta (2010). Significant (P<0.05) effect of genetic groups on egg width as observed in the present findings also reported by Niranjana *et al.* (2008) and Islam and Dutta (2010).

Significant (P<0.01) differences for egg shape index have been observed between the crosses. GP x VR was found to have significantly (P<0.05) higher shape index value than VR x GP cross as well as over the purebreds such as GP x GP and VR x VR. It was indicated that GP x VR chickens may have laid wider eggs as compared to these genetic groups. Alewi *et al.* (2012) reported significant differences

between breeds and their crosses for shape index. Jha and Prasad (2013) found lower value for shape index in Vanaraja and Gramapriya than the findings of the present study. Padhi *et al.* (2013) observed shape index value as 76.49 at 28th week and 77.45 at 72nd week in Vanaraja birds which were in close agreement with the findings of the present study. Significant genotype differences for shape index were also noted by Sarica *et al.* (2012) in five genetic groups and the values for shape indices were in close agreement with the findings of the present study.

The average estimates of shell thickness and shell weight are presented in Table 1. The analysis of variance revealed significant (P<0.01) effect of genetic groups on shell thickness and shell weight. Among the purebreds GP x GP had significantly (P<0.05) thicker shell as compared to that of VR x VR. Crossbred were found to have significantly (P<0.05) thicker shell than both the purebreds. The estimates of mean shell thickness reported by Niranjana *et al.* (2008) in Vanaraja and Gramapriya, Zita *et al.* (2009) in brown egg layer strain and Sarica *et al.* (2012) in Brown and white egg laying strains were in close agreement with the findings of the present investigation. Kumar *et al.* (2014) in RIR and Mohanty and Nayak (2011) reported higher estimates of shell thickness in Vanaraja and other indigenous fowl and some exotic breeds as well as, however, Jha and Prasad (2013) and Alewi *et al.* (2012) reported lower shell thickness than the findings of present study. Significant (P<0.05) breed differences for egg shell thickness as observed in the present study have also been reported in literature by many workers (Jha and Prasad, 2013;). However, Mohanty and Nayak (2011) did not find any significant difference for shell thickness between breeds and strains.

The least squares means and SE of angles corresponding to the percentage of shell weight revealed that the average percentage of shell weight ranged from 17.266g in VR x VR to 18.003g in GP x VR. The significant breed differences for egg shell weight and shell weight percentage observed in the present study have also been reported in the available literature. The average shell weight observed by

Sreenivas *et al.* (2013) and Padhi *et al.* (2013) were in close agreement with the values estimated in the present investigation. Sreenivas *et al.* (2013) and reported breed differences for shell weight and shell weight percentage. The higher average estimate of shell weight reported by Islam and Dutta (2010) and Mohanty and Nayak (2011) as compared to the findings of the other research workers was in accordance with the findings of the present study.

Genetic effect on internal egg quality traits: The average estimate of internal egg quality traits and their comparative study are presented in Table 2. There was significant ($P<0.01$) influence of breeds and their crosses on albumen height. The average estimates of albumen height of the purebreds and their crosses have shown significant ($P<0.01$) differences, however, purebreds and crossbreds did not differ significantly among themselves. The results obtained in the present study are in agreement with the findings of Alewi *et al.* (2012), Sarica *et al.* (2012) and Kumar *et al.* (2014) who reported significant effect of breed and strain on albumen height. The values of albumen height obtained in the present study are also in close agreement to the findings of Niranjana *et al.* (2008) in Vanaraja and Gramapriya. The value of albumen height reported by Sarica *et al.* (2012) and Kumar *et al.* (2014) were higher but in close agreement to the values of GP x VR and VR x GP.

There was significant ($P<0.01$) differences between genetic groups for albumen index. It indicated that all pure and crossbred chickens had better albumen quality than the GP x GP. The VR x GP breed was found to have significantly ($P<0.01$) higher index value than the others. The average albumen index value of VR x VR had shown significantly ($P<0.05$) higher than the GP x GP and GP x VR genetic groups. Evidence on significant effect of breed and strain on albumen quality have been reported in literature by many scientists (Mohanty and Nayak, 2011; Sarica *et al.*, 2012; Sreenivas *et al.*, 2013;). The albumen index obtained by Sarica *et al.* (2012) in different genetic groups of layer and Sreenivas *et al.* (2013) in IWH strain are in close agreement to the cross VR x GP, however, higher than the others in the

present study. Jha and Prasad (2013) obtained lower value than the present study.

Haugh unit is the measure of albumin quality which determines the quality of the egg. The average Haugh unit ranged from 79.38 (GPxGP) to 84.09 (GPxVR) among the genetic groups Table 2. Genetic group had significant ($P<0.01$) effect on the Haugh unit. Among the pure bred Vanaraja performed significantly ($P<0.05$) better than Gramapriya, however there was no significant difference among crossbred for Haugh unit. Similar Haugh unit values of 74.64 (Gramapriya) to 79.42 (Vanaraja) were reported by Niranjana *et al.*, (2008), Padhi *et al.*, (2013) observed 80.76 (Vanaraja at 28th wk) and 81.38 (Vanaraja at 40th wk) of Haugh unit at different ages. Haunshi *et al.* (2011) observed non significant differences in Haugh unit score among Vanaraja and White Leghorn breeds of chickens. Hrnar *et al.*, (2016) observed lower value of Haugh unit in comparison to the present study. The higher Haugh unit in present study indicated the superior quality of the albumin in improved varieties studied.

There was significant ($P<0.01$) effect of genetic groups on yolk height. The GP x GP was also found to have significantly ($P<0.05$) lower yolk height than the GP x VR cross and VR x GP indicating poor yolk quality of GP x GP than the others. The VR x VR chickens though had slightly higher yolk height than the VR x GP but did not differ significantly. Significant breed differences have been reported in literature by many scientists such as Alewi *et al.* (2012), Sarica *et al.* (2012) and Kumar *et al.* (2014). The values of yolk height found in present study are in close agreement to the values obtained by Niranjana *et al.* (2008) in Vanaraja and Gramapriya, Alewi *et al.* (2012) in RIR and crosses and Kumar *et al.* (2014) in RIR. However higher value has been reported by Sarica *et al.* (2012) than the values observed in the present study.

Significant ($P<0.05$) differences for yolk width were observed between the crosses and pure breeds, however, the mean estimates of yolk width in GP x VR crosses was significantly ($P<0.05$) higher than all other genetic groups

Table 2: Least square mean and SE internal egg quality traits

Traits	Genetic groups			
	GP x GP(51)	VR x VR(54)	GP x VR(53)	VR x GP(54)
Albumen height	5.691 ^a ±0.029	5.876 ^a ±0.029	6.757 ^b ±0.028	6.55 ^b ±0.029
Albumen index(%)	7.396 ^a ±0.068	7.802 ^b ±0.067	7.550 ^c ±0.066	8.656 ^d ±0.067
Haugh Unit	79.38 ^a ±0.14	81.35 ^b ±0.37	84.09 ^c ±0.33	83.65 ^c ±0.15
Yolk height(mm)	15.464 ^b ±0.165	16.443 ^a ±0.161	17.350 ^c ±0.160	16.079 ^a ±0.161
Yolk width(mm)	35.513 ^a ±0.245	37.464 ^b ±0.241	40.220 ^c ±0.238	38.567 ^d ±0.241
Yolk index(%)	43.102 ^a ±0.436	43.888 ^a ±0.427	43.201 ^a ±0.423	41.749 ^b ±0.427
Albumen weight	28.513 ^a ±0.169	30.011 ^b ±0.166	34.833 ^c ±0.164	32.283 ^d ±0.166
Yolk weight	13.574 ^a ±0.098	12.692 ^b ±0.096	18.279 ^c ±0.095	13.335 ^a ±0.096
Percent albumen weight	51.478 ^a ±0.082(61.2)	53.156 ^b ±0.081(64.0)	50.346 ^c ±0.080(59.2)	53.033 ^d ±0.081(63.8)
Percent yolk weight	32.745 ^a ±0.009(29.3)	31.324 ^b ±0.008(27.0)	33.850 ^c ±0.008(31.0)	30.867 ^d ±0.008(26.3)

NB- 1.Values present within the parentheses indicating actual percentage.

2. Means with similar superscripts (row wise-abc) did not differ significantly.

of chicken which indicated its superiority over these breeds. The effect of breeds and their crosses on yolk width are scanty in the available literature, however, Alewi *et al.* (2012) reported significant breed effect and the values obtained by them were in close agreement to the present studies. Bornstein and Lipstein (1962) observed the existence of very high and negative correlation between yolk index and yolk width and stated that yolk width increased at the cost of yolk quality and the birds laid eggs with lesser yolk width having better yolk quality.

There was significant ($P<0.01$) effect of genetic groups on yolk index. Significant ($P<0.05$) difference was observed between the crosses. Higher yolk index value in GP x VR than the VR x GP indicated its better yolk quality. Significantly ($P<0.05$) lower yolk index values were observed in VR x GP than the purebreds which suggested that yolk quality of the purebreds might be better than the crosses. The results obtained in the present study corroborated with the findings of Alewi *et al.* (2012), Sarica *et al.* (2012) who reported the existence of breed difference for this trait. The yolk indices obtained by Padhi *et al.* (2013) in Vanaraja were in close agreement to the present study. It is reported that changes in interior quality traits could be expected during egg production period.

There was significant ($P<0.01$) difference for absolute weight of albumen between the genetic groups. The GP x VR was found to have highest albumen weight and differed significantly ($P<0.05$) from other pure and crossbreds of chicken. Significant ($P<0.05$) differences were also observed between GP x GP and VR x VR. Both the crosses were found to have significantly ($P<0.05$) more albumen weight than the purebreds of chicken. The superiority of crosses over purebreds indicated that genes of Gramapriya and Vanaraja combined well for this trait. Significant effect of genotype and breed have been reported by many scientists (Sreenivas *et al.*, 2013, Islam and Dutta, 2010) and the values were in close agreement to the values reported by Niranjana *et al.* (2008), Padhi *et al.* (2013)

in Vanaraja and Gramapriya birds and Sreenivas *et al.* (2013) in White Leghorn strains.

The average estimate of albumen ratio and yolk ratio observed in the present study were lower than the findings of Padhi *et al.* (2013) and Sreenivas *et al.* (2013). The analysis of variance revealed that absolute weight and percentage of egg yolk were significantly ($P<0.01$) influenced by the genetic groups. The GP x VR was found to have significantly ($P<0.05$) more yolk weight than GP x GP, VR x VR and VR x GP which indicated the superiority of GP x VR over other pure and cross breeds for this trait. The lowest yolk weight has been found to be of VR x VR. Between crosses yolk weight of VR x GP has been significantly lower than GP x VR but did not differ significantly from GP x GP. The GP x VR genetic group was found to have significantly ($P<0.05$) more quantity of egg yolk than the purebreds GP x GP, VR x VR and crossbred VR x GP. However, among the purebreds GP x GP was found to have significantly ($P<0.05$) higher yolk weight than VR x VR. Significant ($P<0.01$) effect of genetic groups observed in the present study have also been reported by various scientists (Islam and Dutta; 2010 and Mohanty and Nayak, 2011 and Sreenivas *et al.* ;2013). The values found in the present study were comparable to the values of Niranjana *et al.* (2008) in Vanaraja and Gramapriya, Padhi *et al.* (2013) and Mohanty and Nayak (2011) in Vanaraja. However, Hall (1939) reported that the proportion of total egg weight represented by yolk varies slightly between breeds.

CONCLUSION

The genetic groups were found to have significant effect on egg weight and egg quality traits. The crossbreds were observed to be superior as they laid heavier eggs than the purebreds. Purebred (VRxVR) were found to be superior for albumen index, yolk index and per cent albumen whereas crossbreds were superior for shell thickness, shell weight, shell per cent, which are desirable characteristics for backyard farming.

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