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Genetic and phenotypic parameters estimates for body weight, conformation, production and reproduction traits of PD1 (Vanaraja male line) during different periods

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ABSTRACT

The present study was undertaken to investigate growth, conformation, production and reproduction performance of PD1 (Vanaraja male line). The data collected for different periods from the birds were produced using 50 sires and 250 dams through pedigreed mating. Body weight was 640.21 g and shank length 75.39 mm at 6 weeks of age in pooled sex. In female the shank length increases faster up to 12 weeks of age and at 20 weeks it reached the maximum length, whereas other traits like body weight, keel length and breast angle increased up to 20 weeks of age. The ASM was 188 days and egg production up to 40 weeks of age was 46.29 eggs with egg weight at 40 weeks 54.61 g. The fertility % and hatchability % on total egg set and fertile egg set were 90.46, 83.20, and 91.38 %, respectively. The heritability estimates for juvenile body weight and conformation traits are low in magnitude. Growing period body weight showed moderate heritability estimates, whereas, conformation traits during growing period showed low to moderate heritability estimates. Egg production and age at sexual maturity showed low heritability estimates. Fertility and hatchability % showed moderate heritability estimates. Genetic and phenotypic correlation were estimated between different traits at different period and showed varying levels of correlations estimates. The results indicated that PD1 line has the potential for further improvement and to be used as male line to produce backyard variety and to increase the performance of Vanaraja commercial.

Key words: Body weight, Conformation, Heritability, Production, Reproduction, Vanaraja

Industrial poultry farming is mostly practised in urban and peri-urban areas. However, in remote locality and tribal areas where the infrastructure for the industrial poultry are not available the poor farmers still keep indigenous poultry for backyard poultry farming. The growth and production potential of indigenous birds are poor but due to many other advantages these birds are still popular. People will accept the exotic birds for backyard farming if the exotic birds will perform better in the backyard with very little or no change in management practices that are followed for the local/indigenous birds. Vanaraja an exotic 2-way cross dual purpose bird is being used for backyard poultry farming. Performance of Vanaraja in respect to various aspects is available in literature (Swain *et al.* 2011, Padhi *et al*. 2012a, Kundu *et al*. 2015). However, the genetic and phenotypic parameters estimates of the Vanaraja male line (PD1) are very few (Padhi *et al*. 2012b, Padhi and Chatterjee 2012). So the present study was undertaken to estimate genetic and phenotypic parameters for body weight, conformation, production and reproduction traits in PD1.

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MATERIALS AND METHODS

Experimental population: The birds used for the present study is PD1 line developed from a low producing colour Cornish population (Ayyagari 2008). This line is being selected for higher shank length at 6 weeks of age since last 5 generations. The chicks used for the present study (2,977 survived up to 6 weeks) were produced in 6 hatches using 50 sires and 250 dams. After 6 weeks of age, 777 females were selected for higher shank length and kept for growing. From 12 weeks of age, 523 female birds were kept for growing up to 20 weeks of age. The data for production traits were recorded in 399 birds that were survived up to 40 weeks of age.

Rearing and management: The chicks produced were brooded for 6 weeks under standard brooding practices. Sexing was done after 6 weeks of age and after selection the females were kept in growing cages with standard grower cage management. During laying period the birds were reared in individual cages. Standard feeding and health care facility during, brooding, growing and laying period were followed. During brooding starter ration were provided, during growing period grower feed was provided and feed restriction as per schedule were followed to restrict the female body weight 2,000 g at 20 weeks of age. Layers were provided with meat type layer breeder ration.

Traits measured: Fertility and hatchability data of each dam in different hatches were recorded. Fertility % and hatchability % on total egg set and fertile egg set were calculated. During brooding period body weight were measured at 2, 4 and 6 weeks of age. Conformation traits (shank length, keel length and breast angle) were recorded at 6 weeks of age in pooled sex. After selection during growing period body weight and shank length were recorded at 8, 10, 12, 14, 18 and 20 weeks of age. Keel length and breast angle during growing period were recorded at 8, 12 and 20 weeks of age. Production period data like weight at sexual maturity, body weight at 40 weeks, age at sexual maturity, egg production up to 40 weeks of age and egg production during 21–32, 29–32, 33–36 and 37–40 week of age were measured. Egg weights were recorded at 4 weeks interval starting from 28 weeks and ending at 40 weeks.

Statistical analysis: Data were analysed using least square technique (Harvey 1990) with a computer package and the hatch corrected data were utilized for estimating the heritability estimates by variance component analysis (King and Henderson 1954). Genetic and phenotypic correlations were estimated from variance-covariance component analysis (Becker 1975).

RESULTS AND DISCUSSION

Brooding period: Body weight obtained in the present study at 4 and 6 weeks of age and shank length recorded at 6 weeks of age were higher (Table 1) than the report of Padhi *et al.* (2012a) and Padhi and Chatterjee (2012). It is to be mentioned that PD1 is being selected for higher shank length at 6 weeks of age keeping in view that this can show its effect in Vanaraja commercial through inheritance and heterosis so that higher shank length Vanaraja can run faster in the backyard to escape from predators. Keel length and breast angle obtained in the PD1 line at 6 weeks of age were higher than the report of Gupta *et al.* (2001) in different lines of broiler at 5 weeks of age. As the age of measurement increases keel length and breast angle increases. However, the report of keel length in the same line is not available as far as the authors know.

The heritability estimates for all juvenile body weights and conformation traits are low in magnitude and estimates of dam component variance were higher indicating the importance of dominance or maternal effect for these traits during the early ages (Table 1). Low to moderate heritability for body weights and shank length were report by Padhi *et al.* (2012a) and Padhi and Chatterjee (2012). The low heritability for these traits was due to lower additive genetic variation for these traits in the line. Low heritability estimates for shank length in broiler were reported by Gupta *et al.* (2001). Low heritability estimates for shank length, keel bone length and breast angle at 5 weeks of age was reported by Singh *et al.* (2000) in broiler lines. However, keel length showed moderate heritability in that study. The genetic and phenotypic correlations between juvenile traits are presented in Table 2. The genetic correlations between body weights were high in magnitude. High genetic correlation between body weight with shank length and keel length were also observed indicating that the selection for higher shank length will also improve the other traits as a correlated response. Similar observations were also reported by Padhi *et al.* (2012a) and Padhi and Chatterjee (2012). Correlations between shank length and keel length were positive and high. Similar observation was reported by Gupta *et al.* (2001) in broiler. Correlations of body weights, shank length and keel length with breast angle were low in magnitude. Low genetic correlation between breast angle with keel bone length was reported by Gupta *et al.* (2001).

Growing period: The body weights recorded in the

Table 2. Genetic (above diagonal) and phenotypic (below diagonal) correlations of juvenile traits

	BW2	BW4	BW6	SL6	KL6	BA6
BW2	-	0.84	0.73	0.45	0.67	0.19
BW4	0.51	-	0.97	0.70	0.76	0.28
BW6	0.38	0.60	-	00.70	0.79	0.25
SL6	034	0.55	074	-	0.82	0.14
KL6	0.31	0.44	0.61	0.63	-	0.03
BA6	0.06	0.00	0.16	0.11	0.10	

BW2, BW4, BW6 indicate body weight at 2, 4 and 6 weeks of age, respectively. SL6, KL6, BA6 indicate shank length, keel length and breast angle at 6 weeks of age, respectively.

Table 1. Least square mean±SE and heritability estimates for juvenile body weights and conformation traits in pooled sex

Traits	Mean±SE (2977)	h^2_S	h^2_D	h^2_{S+D}
BW2 (g)	127.98±0.001	0.0198±0.0299	0.2558±0.0604	0.1378±0.0348
BW4 (g)	336.75±0.018	0.1057±0.0443	0.2164±0.0558	0.1611±0.0357
BW6 (g)	640.21±0.033	0.1075±0.0421	0.1552±0.0499	0.1313±0.0327
SL6 (mm)	75.39±0.002	0.0496±0.0312	0.1580±0.0507	0.1038±0.0462
KL6 (mm)	83.74±0.002	0.0697±0.0366	0.1946±0.0540	0.1321±0.0422
BA6 (0)	84.24±0.002	0.0204±0.0191	0.0021±0.0361	0.0112±0.0351

BW2, BW4, BW6 indicate body weight at 2, 4 and 6 weeks of age, respectively. SL6, KL6, BA6 indicate shank length, keel length and breast angle at 6 weeks of age, respectively.

Table 3. Least square estimates (mean±SE) for growing period body weights and conformation traits and heritability in female

Traits	Mean±SE	h^2_S	h^2_D	h^2_{S+D}
Body weight (g)				
BW8	948±0.15 (777)	0.26±0.29	-	0.04±0.07
BW10	1173±0.18(777)	0.33±0.12	0.32±0.16	0.33±0.08
BW12	1400±0.19(777)	0.14±0.09	0.29±0.16	0.22±0.08
BW14	1533±0.26 (523)	0.22±0.12	-	0.09±0.10
BW18	1730±0.28(523)	0.06±0.10	0.18±0.23	0.12±0.10
BW20	1956±0.27(523)	0.16±0.12	0.30±0.23	0.23±0.11
Shank length (mm)				
SL8	88.06±0.50(777)	0.00±0.06	0.13±0.16	0.06±0.07
SL10	97.09±0.53(777)	0.19±0.09	0.06±0.14	0.12±0.07
SL12	103.49±0.57(777)	0.07±0.07	0.11±0.15	0.09±0.07
SL14	105.69±0.74(523)	0.20±0.11	-	0.00±0.10
SL18	107.19±0.70(523)	0.24±0.12	-	-
SL20	108.46±0.66(523)	0.39±0.14	-	0.08±0.11
Keel length (mm)				
KL8	105.08±0.76(777)	0.09±0.07	-	0.01±0.06
KL12	120.86±0.87(777)	0.14±0.09	0.26±0.16	0.20±0.08
KL20	136.64±1.22(523)	0.10±0.09	-	-
Breast angle(0)				
BA8	83.95±0.01(777)	-	0.39±0.18	0.19±0.07
BA12	86.22±0.01(777)	0.07±0.07	0.13±0.15	0.10±0.07
BA20	91.01±0.01(523)	0.03±0.09	-	-

Values in parenthesis in second column indicate number of observations. In the first column BW, SL, KL and BA indicate body weight, shank length, keel length and breast angle, respectively, and the number indicate age in weeks.

female increased slowly and at 20 weeks of age the female attained 1,956 g which was in the range of target body weight of 2,000 kg at 20 weeks of age (Table 3). The body weight obtained at 20 weeks of age was lower than the report of Padhi and Chatterjee (2012) in the same line. Higher body weight at 20 weeks of age in naked neck population was reported by Rajkumar *et al.* (2012) in meat type naked neck population. Shank length increased in gain was 15.43 mm during period from 8 to 12 weeks of age and from 12 to 20 weeks of age the increase in length was only 4.97 mm. The shank length obtained in the present study at 20 weeks of age was higher than that reported by Padhi and Chatterjee (2012). As the age advanced, the increase in gain of shank length decreased and very less increase in shank length was obtained from 18 to 20 weeks of age. Lower shank length at 8 weeks of age was reported in broiler lines (Singh *et al.* 2000) and in naked neck population (Adeyinka *et al.* 2006). Higher shank length in Rhode Island chicken was reported at 20 weeks of age than the present finding in PD1 by Kabir *et al*. (2006). Keel length recorded an increase of 15.78 mm from 8 to 12 weeks and 17.78 mm from 12 to 20 weeks of age indicating the keel length increases with age up to 20 weeks of age. Higher keel length was obtained in the PD1 compared to keel bone length reported in broiler at 8 weeks of age (Singh *et al.* 2000). Breast angle in female showed increase as the age advances and it increases up to 20 weeks of age. Breast angle obtained at 8 weeks of age was higher than the broiler lines as reported by Singh *et al.* (2000). This may be due to breed effect.

The heritability estimates for body weights during growing period ranged from 0.33 to 0.04 from different variance component of estimates (Table 3). Heritability estimates from sire component were lower than the dam component for body weights at 12, 18 and 20 weeks of age indicating the presence of maternal effect. Low heritability for body weight at 8 weeks of age was in agreement with report of Singh *et al.* (2000) and Kumar (2004) in different broiler lines. Dana *et al.* (2011) reported lower heritability at 12 weeks of age in Horro chicken of Ethiopia. Heritability for 20 weeks of age in Vanaraja male line was higher than the present study as reported by Padhi and Chatterjee (2012). Higher heritability in naked neck population was reported by Rajkumar *et al.* (2012). The variation of heritability estimates may be attributed to breed, environment effects and sampling errors. Heritability for shank length during growing period were low to moderate in magnitude and as the age advances the estimates from sire component increases showing more additive genetic effects suggesting the scope of further improvement of the traits towards later part of growing period. Moderate heritability for shank length at 20 weeks was reported by Padhi and Chatterjee (2012). Keel length and breast angle measured during growing period showed moderate to low heritability and also importance of maternal effect as the estimates from

Table 4. Genetic (above diagonal) and phenotypic (below diagonal) correlations of growing period traits (8–12 weeks)

	BW8	BW10	BW12	SL8	SL10	SL12	KL8	KL12	BA8	BA12
BW8		>1	>1	0.37	0.48	–0.07	0.99	0.54	–0.07	0.78
BW10	0.51		>1	0.33	0.73	0.08	0.24	0.70	0.10	0.41
BW12	0.42	0.70		0.76	0.61	0.86	>1	0.53	0.12	0.43
SL8	0.63	0.33	0.29		0.16	–0.17	>1	0.06	–0.12	0.37
SL10	0.49	0.59	0.49	0.43		0.18	0.74	0.80	–0.17	0.27
SL12	0.41	0.50	0.54	0.38	0.58		0.61	0.65	0.20	0.53
KL8	0.49	0.24	0.22	0.58	0.37	0.22		0.83	–0.20	0.44
KL12	0.27	0.35	0.38	0.20	0.26	0.33	0.18		0.30	0.05
BA8	0.07	0.06	0.06	0.06	0.05	0.03	0.06	0.03		0.62
BA12	0.10	0.16	0.20	0.07	0.12	0.13	0.09	0.11	0.06	

In the first column and first row BW, SL, KL and BA indicate body weight, shank length, keel length and breast angle, respectively, and the number indicate age in weeks.

Table 5. Genetic (above diagonal) and phenotypic (below diagonal) correlations of growing period traits (14–20 weeks)

	BW14	BW18	BW20	SL14	SL18	SL20	KL20	BA20
BW14		0.83	0.76	0.03	0.08	0.15	0.18	0.49
BW18	0.76		0.85	0.74	–0.01	0.39	0.78	-
BW20	0.54	0.70		0.19	0.13	0.49	0.11	–0.68
SL14	0.44	0.55	0.25		0.74	0.87	0.63	-
SL18	0.31	0.31	0.20	0.55		0.93	0.69	0.03
SL20	0.24	0.35	0.36	0.43	0.52		0.70	–0.80
KL20	0.23	0.24	0.25	0.21	0.18	0.18		0.69
BA20	0.10	0.18	0.18	0.00	0.03	0.04	0.08	

In the first column and first row BW, SL, KL and BA indicate body weight, shank length, keel length and breast angle, respectively, and the number indicate age in weeks.

dam component were more. Low heritability estimates for keel bone length and breast angle in broiler lines at 8 weeks of age were reported by Singh *et al.* (2000) and Adeyinka *et al.* (2006) in naked neck chicken, which is comparable to the present findings.

The genetic and phenotypic correlations (Tables 4, 5) between body weights were positive and high in magnitude. This was in agreement with the report of Lwelamira *et al.* (2009) and Dana *et al.* (2011) during growing period. Correlation between growing period body weight and shank length did not follow a definite pattern and it varies from negative and very low to high in magnitude. Restriction feeding may be the reason for wide variation during this period. Body weight and keel length shows moderate to high positive correlation. Moderate to low correlations between body weight and keel length was report by Ajayi *et al.* (2012). Body weight with breast angle at different ages shows wide variation. High correlation between body weight and breast girth was reported by Ajayi *et al.* (2012). Correlations between shank length, keel length, breast angle at different ages during growing period were high. High correlation of shank length at different ages in same stock was reported by Padhi and Chatterjee (2012). Moderate to high correlations were obtained between shank and keel lengths, shank length and breast angle and keel length and breast angle measured at different ages. Similar observation was reported by Ajayi *et al.* (2012) in conformation traits.

Laying period: Least square means for different traits along with their heritability estimates during laying period are presented in Table 6. The body weight recorded at 40 weeks of age was lower than the report of Padhi and Chatterjee (2012). Age at sexual maturity and egg weight at 40 weeks of age were better but egg production up to 40 weeks of age was lower than the report of Padhi and Chatterjee (2012). It was observed that with increase in generation there was little improvement in egg production and also in egg weight. The egg production during 29–32, 33 to 36 and 37 to 40 weeks of age increases with the increases of age. Similar observation was observed by Dana *et al.* (2011) in Horro chicken of Ethiopia. Heritability estimates for weight at sexual maturity, body weight at 40 weeks of age, age at sexual maturity, egg production up to 40 weeks of age, egg production at different periods were low in magnitude indicating that there exists less additive genetic variance for these traits in the line. Higher estimates of heritability from dam component of variance indicated the presence of maternal effect for these traits. Moderate estimates for different production traits were reported by Padhi and Chatterjee (2012) in Vanaraja male line, Padhi and Rai (2009) in Nicobari fowl and low estimates for egg

Table 6. Least square mean±SE and heritability estimates for production traits

Traits	Mean±SE (399)	h^2_S	h^2_D	h^2_{S+D}
WASM (g)	2243±0.36	0.08±0.15	0.26±0.26	0.17±0.15
BW40 (g)	2647±0.50	-	0.06±0.24	0.01±0.14
ASM (day)	188.58±0.05	0.10±0.13	-	0.04±0.14
EW28 (g)	47.37±0.01	0.07±0.12	-	-
EW32 (g)	50.95±0.01	-	0.23±0.26	0.05±0.16
EW36(g)	53.58±0.01	0.43±0.20	0.24±0.22	0.34±0.17
EW40 (g)	54.61±0.01	0.26±0.16	-	0.11±0.15
EP40 (no)	46.29±0.04	0.01±0.12	0.06±0.24	0.03±0.14
EP21–32 (no)	16.63±0.03	0.08±0.14	0.16±0.24	0.12±0.14
EP29-32	10.70±0.02	0.16±0.15	0.11±0.23	0.13±0.14
EP33–36	13.82±0.01	-	-	-
EP37–40	16.08±0.03	0.13±0.08	-	-

In first column WASM, BW, ASM, EW, EP indicate weight at sexual maturity, body weight, age at sexual maturity, egg weight and egg production, respectively and the number indicate age in weeks.

Table 7. Least square mean±SE and heritability estimates for reproduction traits

Traits	Mean±SE (986)	h^2_S	h^2_D	h^2_{S+D}
Fertility %	90.46±0.02	-	0.70±0.16	0.33±0.09
Hatchability % (TES)	83.20±0.02	-	0.93±0.18	0.43±0.10
Hatchability % (FES)	91.38±0.02	-	0.88±0.18	0.40±0.09

production, body weight at 52 weeks and age at sexual maturity was reported in a naked neck population (Rajkumar *et al.* 2012). Egg weights showed low to moderate estimates. Moderate to high magnitude of heritability estimates for egg weights were reported by Padhi and Chatterjee (2012) in Vanaraja male line and low to moderate magnitude by Rajkumar *et al.* (2012) in a naked neck population. This is to be mentioned here that the variation in the heritability estimates might be attributed to breed, environment effects and sampling errors. The non-genetic factors like environment and poor management might increase the residual variance and decrease the heritability estimates (Adeyinka *et al.* 2006). The genetic correlation for weight at sexual maturity (WASM) and age at sexual maturity ASM was negative (–0.50) and WASM with egg weight at 28 week were positive (0.40) indicating increase in one trait will increase the other traits as correlated response in the present line. Genetic correlation between egg weight at 40 weeks with egg production up to 40 week of age was negative (–0.49). Negative genetic correlation between egg weight and egg production was reported in different lines (Padhi and Chatterjee 2012, Rajkumar *et al.* 2012).

Reproduction traits: The fertility % and hatchability % obtained in this line (Table 7) were of acceptable range and better than that of Savegnago *et al.* (2011) in F2 reciprocal cross, Haunshi *et al.* (2012) in indigenous Aseel and Kadaknath chicken, and Rajkumar *et al.* (2012) in naked neck population. The heritability estimates were moderate in magnitude in these traits and dam component were higher indicating the presence of maternal ability. The moderate estimate of heritability traits indicated that there is scope for improvement for these traits and hatchability on total egg set should be included as a selection criterion in genetic breeding programs to improve the reproductive performance of the line. Low to moderate heritability estimates for fertility % and hatchability % were reported by Savegnago *et al.* (2011). The genetic correlations of fertility % with hatchability % on total and fertile egg set basis were 0.68 and 0.33 respectively. Genetic correlation between hatchability % of total egg set and fertile egg set was high (0.91). The phenotypic correlation between fertility % with hatchability % on total and fertile egg set were 0.69 and 0.17, respectively, whereas, phenotypic correlation between hatchability % on total egg set and fertile egg set was 0.78. The correlation estimates obtained between different reproductions traits were in agreement with the report of Savegnago *et al.* (2011). Correlation estimates between different reproduction traits indicates that the improvement in one of the traits will improve the other traits as a correlated response.

Vanaraja an exotic 2-way cross dual purpose bird is being used for backyard poultry farming. The performances of Vanaraja in respect to various aspects are available in literature. However, the genetic and phenotypic parameters estimates of the Vanaraja male line (PD1) are very few. So the present study was undertaken to estimates genetic and phenotypic parameters for body weight, conformation, production and reproduction traits in PD1 during brooding, growing and laying period. The results revealed that the line can be further improved in respect to different traits and have the potential as a male line for the production of backyard chicken as a cross combination with other female lines by exploitation of heterosis. The higher shank length along with mediocre body weight of the line may be of great use for the development of dual type germplasm and further improvement of Vanaraja commercial which is a popular dual purpose backyard variety.

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