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A study on bilateral asymmetry in PD1, control broiler and *Vanaraja* commercial chickens

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ABSTRACT

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The study was conducted on 814 chicks of PD1, 124 Control broiler and 128 *Vanaraja* commercial chickens for 7 weeks body weight and bilateral asymmetries for shank length (SL) and shank width (SW). The inheritance of these traits in PD1 were studied. Body weight and trait size for SL and SW were significantly (P<0.05) higher in Control broiler followed by PD1 and *Vanaraja* irrespective of sexes except trait size for SL in PD1 and control broiler were non significant. Males recorded significantly (P<0.05) higher body weight and trait size in all the three genetic groups. Fluctuating asymmetry and relative asymmetries for SL and SW differed significantly (P<0.05) between genetic groups irrespective of sexes. Most of the bilateral asymmetry traits were significantly (P<0.05) lower in control broiler than PD1 and *Vanaraja*. Males recorded significantly (P<0.05) higher fluctuating, bilateral and directional asymmetries for SL in PD1. In control broiler and *Vanaraja* no significant (P<0.05) differences were observed between sexes for any of the bilateral asymmetry traits studied. The heritability estimates of different bilateral asymmetries in pooled sex were found to be low (0.00 to 0.17). Genetic and phenotypic correlation estimates between different traits were measured. Lower bilateral asymmetries in control broiler compared to PD1 and *Vanaraja* suggest that Control broiler being an unselected population the asymmetries were less compared to PD1 which was selected for shank length and *Vanaraja* which is a crossbred. Developmental stability was best in Control broiler followed by PD1 and *Vanaraja*.

Key words: Asymmetry, correlation, fluctuating asymmetries, heritability, traits size

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INTRODUCTION

Developmental stability shows the capacity of a genome to produce stable phenotype under a given range of environmental conditions (Moller and Swaddle, 1997). Bilateral asymmetric morphological characters with fluctuating asymmetries usually have a small, random deviation from symmetries that reflect the ability of individuals to cope with genetic and environmental stress (Moller *et al*., 1995). Increased fluctuating asymmetries has been correlated with a variety of stress factors such as non optimal temperature, inefficient nutrition, various chemicals, high population density and noise among others (Moller and Swaddle, 1997). Since fluctuating asymmetries also have a genetic component, genetic difference can be a confounding factor that needs to be considered. Therefore, increased asymmetries may be due to any of these or other factors and a diagnosis of specific factors responsible must still be made for each case (Klingenberg, 2003). Strong directional selection imposed by animal breeders showed the results in elevated level of fluctuating asymmetries (Moller *et al*., 1995). Hybridization may also improve genetic stress associated with increased likelihood of break down in genomic co-adaptation i.e. homeostasis (Zhakarov, 1992). The heritability of fluctuating asymmetries were reported to be low (Campo *et al*., 2005; Singh *et al*., 2012). Reported in this paper are comparisons of bilateral asymmetries in chicken from selected line used for development of backyard poultry, one unselected control broiler line and one dual type backyard commercial cross of selected lines. Study on inheritance pattern of bilateral traits and their association with body weight in selected line was also made.

MATERIALS AND METHODS

Genetic stocks and management

The chickens used in this experiment were PD1 line which has been selected for high shank length for six weeks of age for last six generations. This line was developed from a Cornish population (Ayyagari, 2008). PD1 line is being used as male parent for the commercial *Vanaraja* dual purpose backyard poultry variety. Eight hundred fourteen pedigreed day old chicks of PD1 were produced in a single hatch using 50 sires and 250 dams. They were reared along with 124 Control broiler and 128 *Vanaraja* commercial birds. Control broiler is a pedigreed meat type control being maintained since last 10 generations and *Vanaraja* is a commercial dual purpose backyard poultry variety produced by crossing PD1 with PD2 (female parent).The chicks were reared under standard management and feeding conditions upto 7 weeks of age under deep litter system with open sided shed.

Data collection

Body weight of each individual bird was recorded at 7 weeks of age. Same day two bilateral traits data was

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obtained in males and females. Shank length (0.01 mm) and shank width (0.01 mm) of both left and right shank were recorded with a digital vernier calliper. The measurer and holder of the chickens were same for all the measurements. Fluctuating asymmetries (FA) for each bilateral trait was calculated as unsigned difference between left and right measurement. The trait sizes (TS) for the two bilateral traits was estimated as the mean of both the sides. Relative asymmetry (RA) was defined as the ratio of the absolute value of left- right (FA) divided by TS multiplied by 100 (RA= [FA/TS] X 100). Directional asymmetry (DA) was calculated as signed difference of right and left measure of the trait. The traits were calculated for both male and female in all the genetic groups.

Statistical analysis

Data of different traits were analysed for significance between genetic groups in the sexes as well as difference between male and female for a particular trait within a genetic group as per Snedecor and Cochran (1989). Prior to analysis RA were transformed to arc-sine square roots. Genetic parameters were estimated based on full sib analysis (Becker, 1975).

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RESULTS AND DISCUSSIONS

Body weight and traits size

The mean of body weight and traits size at 7 weeks of age are presented in Table 1 for both male and female. Body weight was significantly higher in Control broiler followed by PD1 and *Vanaraja* irrespective of sexes. Padhi *et al.* (2012a) reported significant difference between PD1, Control broiler and *Vanaraja* for juvenile body weights. Singh *et al.* (2012) reported significant difference for body weight in a selected meat type stocks and a control meat type stocks. Significant (P<0.05) differences between male and female were observed in all the genetic groups for body weight which is in agreement with report of Padhi *et al.* (2012a). Traits size for shank length (SL) and shank width (SW) were significantly higher in Control broiler compared to PD1 and *Vanaraja* in male however in female no significant difference for shank length was observed between PD1 and Control broiler. *Vanaraja* recorded significantly (P<0.05) lower SL and SW than other two genetic groups irrespective of sex. Significant difference for SL was reported by Padhi *et al.* (2012a) in three genetic groups and Bajwa *et al.* (2007) in two meat type stocks. It is to be mentioned here that PD1 being selected for higher shank length there is improvement of shank length so the shank length in female of Control broiler and PD1 are almost at same length though the body weight was higher in Control broiler. Male birds recorded significantly higher traits size in respect to SL and SW in all the three genetic groups. Singh *et al.* (2012) reported significant traits size for SL and SW in male than female in two meat type stocks.

Table 1: Means (± SE) of body weight and traits size (shank length and shank width) at 7 weeks of age in PD1, control broiler and *Vanaraja*

Trait	Male		
	PD1 (384)	Control broiler (58)	*Vanaraja* (62)
Body weight (g)	953±7.49^{bA}	1121±19.10^{aA}	725±9.52^{cA}
Trait size (Shank length) (mm)	88.48±0.25^{bA}	90.74±0.68^{aA}	79.43±0.54^{cA}
Trait size (Shank width) (mm)	11.93±0.05^{bA}	12.55±0.16^{aA}	9.74±0.09^{cA}
Trait	Female		
	PD1 (430)	Control broiler (66)	*Vanaraja* (66)
Body weight (g)	863±6.15^{b}	905±15.67^{a}	530±9.41^{c}
Trait size (Shank length) (mm)	84.34±0.25^{a}	84.12±0.57^{a}	71.08±0.58^{b}
Trait size (Shank width) (mm)	10.95±0.25^{b}	11.62±0.12^{a}	8.59±0.10^{c}

Figures in parenthesis indicate number of observation. Means having different superscript lower case in a row differ significantly (P<0.05). Means having upper case superscript "A" indicates significant (P<0.01) difference between male and female for a particular genetic group for a trait.

Fluctuating asymmetry

Fluctuating asymmetry for shank length ((FASL) and shank width (FASW) differed significantly (P<0.05) between genetic groups in both male and female (Table 2). In both the sexes FASL and FASW was significantly

Table 2: Means (±SE) of bilateral traits asymmetries at 7 weeks of age in PD1, control broiler and *Vanaraja*

Bilateral asymmetry	Male		
	PD1 (384)	Control broiler (58)	*Vanaraja* (62)
FASL (mm)	1.52±0.05^{aA*}	1.00±0.11^{b}	1.49±0.13^{a}
FASW (mm)	0.60±0.02^{a}	0.40±0.04^{b}	0.72±0.07^{a}
RASL (%)	1.73±0.06^{aA**}	1.10±0.12^{b}	1.88±0.16^{a}
RASW (%)	4.98±0.20^{b}	3.21±0.31^{c}	7.23±0.66^{a}
DASL (mm)	0.197±0.09	0.08±0.17	-0.281±0.22
DASW (mm)	0.048±0.04	0.017±0.06	-0.031±0.11
	Female (430)	(66)	(66)
FASL (mm)	1.26±0.0.04^{a}	0.97±0.08^{b}	1.53±0.14^{a}
FASW (mm)	0.57±0.02^{ab}	0.45±0.04^{b}	0.63±0.05^{a}
RASL (%)	1.498±0.05^{b}	1.15±0.10^{c}	2.169±0.19^{a}
RASW (%)	5.37±0.19^{b}	3.84±0.37^{c}	7.24±0.62^{a}
DASL (mm)	-0.081±0.08^{A*}	0.002±0.14	-0.526±0.22
DASW (mm)	0.124±0.03	-0.005±0.07	0.034±0.09

In first column FA, RA and DA indicates fluctuating asymmetry, Relative asymmetry and directional asymmetry, respectively. SL indicates for Shank length and SW indicates shank width. Figures in parenthesis indicate number of observation. Means having even one different superscript lower case in a row differ significantly (P<0.05). Mean having uppercase superscript A* and A** indicates the male differ significantly than female for that trait in that genetic groups at P<0.05 and P<0.02, respectively.

higher in *Vanaraja* followed by PD1 and Control broiler. Further, males of PD1 recorded significantly higher FASL and FASW than females but in control broiler and *Vanaraja* no significant differences between male and female were observed. Significant difference between FASL and FASW was reported by Singh *et al.* (2012) for shank length and shank width in PB2 and control population. Non significant FASL for shank length was reported by Bajwa *et al.* (2007) in PB1 and a commercial broiler. Control broiler in which no selection was made showed lowest FASL and FASW than PD1 and *Vanaraja* which is in agreement with reports of a selected and control line by Singh *et al.* (2012). Yang *et al.* (1997) showed lower FASL and FASW in a selected line compared to the line where selection were relaxed. They also reported lower value for F1 cross than selected and relaxed line. However, in our study the *Vanaraja* commercial showed higher values. Non significant higher value in commercial stocks than selected line was reported by Bajwa *et al.* (2007). Lower fluctuating asymmetry in Red jungle fowl compared to selected meat type breeds was reported by Moller *et al.* (1995). Intense directional selection has been hypothesized to increase the overall developmental stability as measured by FA, where as stabilizing selection has been hypothesized to have the opposite effect (Moller and Pomiankowski, 1993a, b). No significant difference for FASL and FASW for Control broiler and *Vanaraja* was in agreement with the report of Singh *et al.* (2012) and Bajwa *et al.* (2007).

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Relative asymmetry

Relative asymmetry for shank length (RASL) and shank width (RASW) differ significantly ($P<0.05$) between the three genetic groups irrespective of sexes. Sex effect was significant only for RASL in PD1. Singh *et al.* (2012) reported significant sex effects for RASL which is in agreement with PD1. Amongst the three genetic groups studied *Vanaraja* recorded highest RASL and RASW in both the sexes followed by PD1 and control broiler. Significant difference between RASL and RASW was reported by Singh *et al.* (2012). Lower relative asymmetry in Red jungle fowl compared to selected breeds reported by Moller *et al.* (1995) in respect to different bilateral traits. Yang *et al.* (1997) reported lower bilateral asymmetry in crosses than the selected lines. For shank length and shank diameter significantly lower RASL and RASW in control broiler than PB2 was reported by Singh *et al.* (2012). *Vanaraja* commercial has lowest developmental stability compared to PD1 and control broiler. Since RA appears to differ amongst stocks it implied that it may be due to genetic stress.

Directional asymmetry

Directional asymmetry calculated in males and females in three genetic groups are presented in Table 2. No significant difference between genetic groups for directional asymmetry for shank length (DASL) and shank width (DASW) in males and females were observed. DASL was significantly higher in males than females in PD1. No significant difference for DASL and DASW at five weeks of age and lower DASL and DASW value in control line than selected line was reported by Singh *et al.* (2012). Directional asymmetry was negative in *Vanaraja* compared to other lines in males. The genetic modification made by phenotypic selection for a particular trait is mainly due to additive genetic effect associated with reduction in genetic variation consequently increasing the bilateral asymmetry. Selection also directly affects allele that control developmental homeostasis and against genetic modifiers that control development of extreme phenotypes (Moller *at al*., 1995).

Genetic parameters

The heritability estimates for body weight, trait size of bilateral traits and different bilateral asymmetry at 7 weeks of age in PD1 is presented in Table 3. The heritability estimates from different component for body weight varies from 0.15 to 0.38 and the dam component was higher than the sire component indicating the importance of maternal effect and or environmental error. Low to moderate heritability for body weight in PD1 was reported by Padhi *et al.* (2012b) and Padhi and Chatterjee (2012). Low heritability estimates for body weight was reported by Singh *et al.* (2012) in a meat type stock. The trait size heritability estimates for both shank length and shank width was low to moderate in magnitude and estimates from dam component was higher. A similar report for shank length was reported by Padhi *et al.* (2012b) and for shank length and shank width by Singh *et al.* (2012). High heritability estimates for Leghorn lines was reported by Campo *et al.* (2005). Heritability estimates for FASL and FASW varies from 0.01 to 0.06 from different components of estimates. Low heritability estimates from

Table 3: Heritability estimates from different components of body weight, traits size of bilateral traits and bilateral asymmetries at 7 weeks of age in PD1

Trait	h^2_S	h^2_D	h^2_{S+D}
Body weight	0.15±0.09	0.38±0.15	0.27±0.08
Trait size (Shank length)	0.08±0.08	0.36±0.16	0.22±0.07
Trait size (Shank width)	-	0.23±0.15	0.09±0.06
FASL	0.03±0.06	-	-
FASW	0.05±0.06	-	0.01±0.06
RASL	0.02±0.05	-	0.00±0.05
RASW	0.06±0.06	0.03±0.13	0.04±0.06
DASL	-	0.16±0.15	0.06±0.06
DASW	0.17±0.08	-	0.02±0.06

FASL and FASW= Fluctuating asymmetry shank length and shank width, RASL and RASW= Relative asymmetry shank length and shank width, DASL and DASW = Directional asymmetry shank length and shank width.

Table 4: Genetic and phenotypic correlations between body weight, traits size of bilateral traits and bilateral asymmetries at 7 weeks of age in PD1 (sire component of variance and co-variance)

Trait	BW7	TSSL	TSSW	FASL	FASW	RASL	RASW	DASL	DASW
BW7		>1	-	>1	-0.18±0.64	>1	-0.37±0.61	-	-0.37±0.40
TSSL	0.82		-	>1	0.26±0.93	>1	0.12±0.89	-	-0.46±0.56
TSSW	0.19	0.19		-	-	-	-	0.56±1.18	-
FASL	0.07	0.07	0.09		<-1	1.00±0.03	<-1	-	-0.65±0.58
FASW	0.03	0.01	0.01	0.03		<-1	0.96±0.05	-	0.55±0.58
RASL	0.00	-0.01	0.08	0.99	0.04		<-1	-	-0.64±1.00
RASW	-0.05	-0.07	-0.05	0.02	0.98	0.03		-	0.61±0.56
DASL	-0.00	0.00	0.09	0.04	-0.00	0.03	-0.02		-
DASW	0.01	0.00	0.03	-0.06	0.03	-0.06	0.06	-0.05	

BW7= body weight at 7 weeks of age, TSSL= trait size shank length, TSSW= trait size shank width, FASL and FASW= Fluctuating asymmetry shank length and shank width, RASL and RASW= Relative asymmetry shank length and shank width, DASL and DASW= Directional asymmetry shank length and shank width. Above diagonal value genetic correlation estimates from sire component of variance and covariance, below diagonal phenotypic correlation

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different components for RASL, RASW, DASL and DASW were observed. Lower heritability estimates for different bilateral traits are in agreement with the reports of Campo *et al*. (2005) and Singh *et al*. (2012). Bilateral asymmetry were determined mainly by environmental source of variation and was not be confounded by appreciable additive genetic contribution (Singh *et al*., 2012). The present finding also indicates the similar trends.

Genetic and phenotypic correlation between 7 weeks body weight, traits size for SL and shank width and different bilateral asymmetries are presented in Table 4. Body weight has negative correlation with RASW and DASW but moderate in magnitude. Negative genetic correlation for body weight with DASW and RASW was reported by Singh *et al*. (2012). Genetic correlation between different bilateral traits varies from -0.61to 1.00 and phenotypic correlation from -0.06 to 0.99. The phenotypic correlation was low in magnitude compare to genetic correlation.

The results indicates that measure of developmental stability such as fluctuating asymmetry, relative asymmetry and directional asymmetry provide an easy useful mechanism for animal breeding and animal welfare problems. Significant difference between genetic groups for fluctuating and relative asymmetry and low heritability estimates for this traits indicates that both genetic and environment played a role in the traits and may be considered during selection programme.

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