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Evaluation of terminal crosses to assess the suitability of PD-6 line as a male line for *Gramapriya* chicken variety developed for rural poultry

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ABSTRACT

The comparative performance of the terminal crosses involving either Poultry Directorate-6 (PD-6) or Poultry Directorate-2 (PD-2) lines as male and Poultry Directorate-3 (PD-3) line as female parents was evaluated to study the suitability of PD-6 line for production of *Gramapriya* rural chicken variety utilizing the performance data on 534 birds belonging to PD-6×PD-3 (254) and PD-2×PD-3 (280) crosses. The body weights were significantly higher in PD-6×PD-3 cross from four weeks onwards to till 14 weeks of age. Similarly, the shank length was also significantly higher in PD-6×PD-3 than PD-2×PD-3 cross at 4, 6 and 8 weeks of age. Sex significantly influenced the body weights from 4th week onwards in PD-6×PD-3 cross and from 6th week onwards in PD-2×PD-3. The adult body weights of females in both the crosses did not vary significantly except at 52 weeks of age. The live weight and dressing percentage were significantly higher in PD-6×PD-3 cross. All the slaughter parameters were similar in both the crosses without any significant variation except gizzard and feather proportions, which were significantly higher in PD-2×PD-3.The annual egg production in PD-6×PD-2 and PD-2×PD-3 crosses was 247.33 and 255.73 eggs, respectively. Therefore, the study concluded that, PD-6 line might be a suitable male line for production of *Gramapriya* chicken variety without affecting the performance.

Key words: Backyard poultry, Body weight, Egg production, *Gramapriya*

The basic advantage of backyard poultry is that mostly the activity has been managed by women in the family leading to women empowerment (Rajkumar *et al*. 2010, Sambo *et al*. 2015). Various pure lines which were developed through genetic selection are being used to develop crossbreds for backyard poultry farming involving native and exotic strains (Ayyagari 2008, Padhi *et al*. 2016). *Gramapriya*, a prolific brown egg layer developed for rural poultry has been well accepted all over the country (Rajkumar and Rama Rao 2015). The variety has been produced by utilizing Poultry Directorate-2 (PD-2) as a male line and Poultry Directorate-3 (PD-3) as female line. However, PD-2 line is being used as the female line for Vanaraja also, an established dual purpose chicken variety. As PD-2 line is used as both male and female lines for two varieties leading to a complex situation to apply proper selection and breeding program as it was difficult to apply suitable selection criteria for male and female lines in a single population. Therefore, a new male line, Poultry Directorate-6 (PD-6) line was evolved from PD-2 line by applying selection for higher shank length at six weeks of age over last six generations. In the present study, the performance of the terminal crosses involving newly developed PD-6 and PD-2 lines as male and PD-3 as female parents was evaluated to study the suitability of PD-6 line for production of *Gramapriya* rural chicken variety.

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MATERIALS AND METHODS

Experimental population: A total of 534 (254: PD-6 ×PD-3 and 280: PD-2×PD-3) chicks produced in a single hatch were utilized for evaluating the growth, carcass and production performance in two crosses up to 72 weeks of age. The chicks were reared under intensive farm system at experimental farm of ICAR-Directorate of Poultry Research, Hyderabad. PD-2 line is a synthetic population evolved from mediocre control broiler population and is being used as male line for production of Vanaraja. PD-3 is evolved from Dahlem Red population and being selected for higher egg production over the generations and is the female line for *Gramapriya* chicken. PD-6 line (Fig. 1) was evolved from PD-2 line and being

Fig. 1. Adult male and female birds of PD-6 line

stabilized for the production performance since last six generations. The population is being improved for higher shank length at 6 week of age which helps birds in running faster to escape from predator while grazing in the field.

Rearing and management practices: The chicks were sexed and wing banded on day one and reared in a deep litter system, with a decreasing temperature schedule from 33°C during first week to 23°C at the end of fifth week in an open-sided house under standard management practices. The chicks were fed *ad-libitum* with broiler starter (ME, 2900 Kcal; CP, 22%) diet based on maize-soybean meal up to 6 weeks of age.

The females were maintained on restriction feeding schedule from seventh week onwards to maintain the target body weight during the laying cycle for better egg production. However, the males were on full feeding till slaughter age (14 weeks). The birds were maintained on a broiler grower ration (ME, 2600 Kcal; CP, 18%) upto 16 weeks of age. Hundred hens in each cross were reared upto 72 weeks of age in individual cages on broiler breeder ration (ME, 2700 Kcal; CP, 17%; Calcium, 3.5%) till the end of the production cycle. The birds were vaccinated against Marek's disease (1st day), Newcastle disease (ND), Lasota (7th and 30th day), infectious bursal disease (14th and 26th day), fowl pox (6th week), ND R_2B (9th week), infectious bronchitis (IB) and ND inactivated (18th week).

Traits measured: Juvenile growth traits such as body weights (day old, 2, 4, 6, 8 and 14 weeks); shank lengths (4, 6 and 8 weeks) and adult body weights (20, 40, 52, 64 and 72 weeks) were measured. The production parameters like age at sexual maturity (ASM), egg weight (28, 32, 36, 40,52,64 and 72 weeks) and egg production (40, 52, 64 and 72 weeks) were recorded in hens up to 72 weeks of age.

Carcass traits: A total of 20 cocks were selected randomly and sacrificed by cervical dislocation for evaluating the carcass traits at 14 weeks of age. The relative weights of dressed carcass, dressing percentage (DP), cutup parts (breast, legs, wings and back), giblets (gizzard, liver and heart) and offals (feather, head and blood), abdominal fat and immune organs (bursa and spleen) were recorded and expressed as percentage of live weight.

Statistical analysis: The data collected on various traits were analyzed using two factor ANOVA model to assess the effect of genotype and sex on juvenile traits and single factor ANOVA was employed to research the effect of genotype on all other traits (Snedecor and Cochran 1994).

RESULTS AND DISCUSSION

Juvenile traits: Least square means for body weight from day old to 14 weeks of age are presented in Table 1. The body weights were significantly (P≤0.05) higher in PD-6×PD-3 cross from four weeks onwards to till 14 weeks of age. Similarly, the shank length was also significantly (P≤0.05) higher in PD-6×PD-3 than PD-2×PD-3 cross at 4, 6, and 8 weeks of age (Table1).The body weights recorded in the present crosses were lower than Vanaraja and higher than *Gramapriya* varieties (Haunshi *et al*. 2009); higher than 3-way and 2-way cross (Padhi *et al*. 2014, 2016) developed for backyard poultry farming. The lower body weights in the present crosses than Vanaraja and other crosses was justified as these crosses are of egg type varieties developed for rural poultry with high egg production potential. The lower body weights also substantiate the fact that body weight and egg production are negatively correlated. Higher body weights were reported in broiler crosses during the juvenile phase compared to the present findings (Rajkumar *et al*. 2011). The shanks were longer in the present cross at 8 weeks of age compared to a 3-way cross developed for rural poultry (Padhi *et al*. 2016). Increase in higher shank length may be due to heterosis effect in two way cross which might have regressed in three way cross leading to smaller shank length. The PD-6 was evolved from PD-2, which was selected for higher body weight initially and higher egg production at later stage (52 weeks of age). However, the selection criterion in PD-6 was longer shank length since last six generations resulting into increased shank length as compared to PD-2, which might have reflected in higher shanks in offspring. Therefore, the cross of PD-6×PD-3 was having significantly higher shank length as compared to PD-2×PD-3, which may be due to non-additive interactions of the genes. The shank length and body weights were positively correlated resulting into higher body weights of crosses of PD-6×PD-3. Similar results were reported by Gupta *et al*. (2001), Padhi *et al*. (2012), Ojo *et al*. (2014), wherein the genetic correlation between shank length and body weight were positive and high. It may be inferred that PD-6 which was selected for higher shank length indirectly improved the body weights too as correlated response. Higher body weights were reported in broiler crosses during the juvenile phase compared to the present findings (Rajkumar*et al*. 2011). Sex significantly influenced the body weights from 4th week onwards in PD-6×PD-3 and from 6th week onwards in PD-2×PD-3 cross. The sex of the chicks had no influence on the body weight up to 4 weeks in case of PD-6×PD-3 and upto 6 weeks in PD-2×PD-3 cross

Table 1. Body weight and shank length in terminal crosses at different ages during juvenile phase

Trait	n	PD-6×PD-3	n	PD-2×PD-3	P
Body weight (g)					
0 day	254	35.53±0.30	280	36.04±0.32	0.247
2 wks	247	125.97±1.73	271	126.90±1.88	0.716
4 wks	242	342.60±4.62^a	268	318.00±5.01^b	0.001
6 wks	242	602.69±7.39^a	263	515.88±8.01^b	0.001
8 wks	238	930.55±11.00^a	259	859.29±11.92^b	0.001
14 wks	232	1610.82±15.12^a	253	1462.51±13.87^b	0.001
Shank length (mm)					
4 wks	242	59.48±0.33^a	268	57.31±0.35^b	0.001
6 wks	242	75.99±0.39^a	263	70.62±0.42^b	0.001
8 wks	238	90.92±0.45^a	259	86.34±0.49^b	0.001

^{a,b}Means with different superscripts differ significantly (P≤0.05).

Table 2. Effect of sex on body weight and shank length in terminal crosses

Trait	PD-6×PD-3					PD-2×PD-3				
	n	Male	n	Female	SEM	n	Male	n	Female	SEM
Body weight (g)										
0 day	124	35.75	130	35.32	0.32	152	35.55	128	36.53	0.30
2 wks	119	128.09	128	123.85	1.85	147	126.76	124	127.04	1.76
4 wks	117	356.22[a]	125	328.99[b]	4.95	144	327.20	124	308.80	4.69
6 wks	117	641.22[a]	125	564.17[b]	7.90	141	559.21[a]	122	472.54[b]	7.50
8 wks	116	1027.08[a]	122	834.12[b]	11.76	139	939.86[a]	120	778.72[b]	11.16
14 wks	112	1894.22[a]	120	1327.34[b]	18.54	136	1745.84[a]	117	1178.45[b]	16.88
Shank length (mm)										
4 wks	117	60.85[a]	125	58.10[b]	0.35	144	58.42[a]	124	56.19[b]	0.33
6 wks	117	78.64[a]	125	73.35[b]	0.42	141	73.56[a]	122	67.68[b]	0.40
8 wks	116	95.38[a]	122	86.45[b]	0.48	139	90.44[a]	120	82.24[b]	0.46

[a, b]Means with different super scripts differ significantly (P≤0.05)

(Table 2). Sexual dimorphism was clearly observed in crosses with significantly higher body weights in males than females. The sexual dimorphism observed in the present study was similar to the findings of Ajayi and Ejio (2009), Padhi *et al*. (2012; 2016), Rajkumar *et al*. (2017) in rural chicken varieties. Sexual dimorphism for shank length was evident from four weeks onwards in both crosses. The shank length of males was higher (P≤0.05) than females in both crosses (Table 2) similar to the body weights indicating the positive correlation between the shank length and body weight. The significantly higher body weight noticed in PD-6×PD-3 cross was an added advantage of new PD-6 line as a male parent in the cross as it earn more money for the farmers.

Adult body weight: The adult body weights of females in both the crosses did not vary significantly except at 52 weeks of age wherein, the body weight of PD-6×PD-3 cross was significantly (P≤0.05) higher than that of PD-2×PD-3 cross (Table 3). The adult body weights observed in the present study were lower than that of Vanaraja and higher than that of *Gramapriya*. The lower body weight of PD-6×PD-3 cross than Vanaraja may due to the fact that the average body weights of Vanaraja parents were higher than that of PD-6×PD-3 cross, *Gramapriya* and three way crosses. Similar results were reported by Niranjan *et al*. (2008) and 3-way cross (Padhi *et al*. 2016) developed for rural poultry farming. The body weight at 72 weeks of age was higher (2.8 kg) which may fetch better sale price at the end of the laying cycle. The higher body weights are advantageous to the farmers as it fetches higher price there by increasing the returns from the poultry unit. Higher body weight without compromising the egg production is an additional advantage of these birds over the native birds.

Table 3. Adult body weights (g) of hens in terminal crosses involving PD-2 and PD-6 chicken

Age	n	PD-6×PD-3	n	PD-2×PD-3	P
20 wks	114	1805.89±23.73	110	1778.84±23.15	0.433
40 wks	108	2371.92±42.42	106	2295.75±30.36	0.183
52 wks	104	2540.21±44.78[a]	101	2402.14±35.94[b]	0.027
64 wks	98	2699.70±49.99	93	2764.75±39.29	0.599
72 wks	94	2849.22±55.37	89	2762.93±40.26	0.248

[a,b]Means with different superscripts differ significantly (P≤0.05)

Carcass traits: The data on slaughter variables of male birds at 14 weeks of age expressed as percentage of live weight are presented in Table 4. The live weight and dressing percentage were significantly (P≤0.05) higher in PD-6×PD-3 cross. This was in desirable direction as it increases meat yield and hence economizes the returns to the farmers. All the slaughter parameters were similar in both the crosses without any significant variation except gizzard and feather proportions, which were significantly (P≤0.05) higher in PD-2×PD-3 (Table 4).The males are utilized for meat purpose at the age of 12–15 weeks based on the body weight in rural poultry farming. Meat quality and carcass traits are important indices to measure performance of meat birds (Rajkumar *et al*. 2016; 2017) and their suitability for human consumption and to convince and satisfy the consumers.The dressing percentage was within standard normal ranges (65–75%) as observed by many authors (Rajkumar *et al*. 2011, Haunshi *et al*. 2013, Sarsenbek *et al*. 2013, Rajkumar *et al*. 2016) in chicken. The abdominal fat percentage was lower in the present crosses than the commercial broiler meat, similar to the Aseel chicken meat (Rajkumar *et al*. 2016), which is a desirable character for a dual purpose rural bird. Similarly, low proportion of abdominal fat was reported by Haunshi *et al*. (2013), Padhi *et al*. (2013) in native and rural chicken varieties. The lower proportion of abdominal fat may be due to open grazing by rural chicken varieties which need a lot of energy for searching food resulting in lesser deposition of abdominal fat. However, in contrast Bogosavljevic-Bosokovic *et al*. (2006) reported non-significant affect of rearing system (free-range and extensive indoor) on the proportions of major carcass parts and of abdominal fat in broiler chickens. However, Mikulski *et al*. (2011) reported that body weight, meat yield and quality of chickens were primarily due to genotype.

Table 4. Slaughter parameters in terminal crosses expressed as percentage of live weight

Parameter	PD-6×PD-3 (n=20)	PD-2×PD-3 (n=20)	P
Live weight, g	1923.40±58.28[a]	1781.55±42.08[b]	0.05
Dressing percentage, %	72.71±0.36[a]	71.19±0.41[b]	0.008
Breast	16.00±0.32	15.55±0.38	0.380
Legs	21.35±0.29	20.87±0.24	0.211
Wings	9.89±0.16	9.51±0.16	0.102
Back	21.53±0.34	20.77±0.31	0.105
Heart	0.45±0.02	0.44±0.01	0.879
Liver	1.94±0.06	2.15±0.10	0.069
Gizzard	2.00±0.07[b]	2.32±0.07[a]	0.002
Abdominal fat	0.74±0.12	0.66±0.11	0.706
Bursa	0.10±0.01	0.10±0.02	0.771
Spleen	0.15±0.01	0.18±0.01	0.101
Blood	4.62±0.31	4.77±0.60	0.934
Head	3.31±0.09	3.34±0.06	0.743
Feather	5.72±0.26[b]	7.49±0.53[a]	0.022

[a,b]Means with different superscripts differ significantly (P≤0.05).

Certainly, multiple factors including genotype, age, sex, diet, density, environment, exercise and pasture intake impact the growth and performance of birds (Gordon and Charles 2002). Less abdominal fat is a preferred trait in broilers and meat type birds and customers prefer low fat chicken meat (Ying *et al.* 2016).

Production performance: The ASM, egg weight and egg production did not vary significantly in both the crosses (Table 5). The egg weights were numerically higher in PD-6×PD-3, which might be due to the higher body weights of the cross compared to PD-2×PD-3 cross. The annual egg production in PD-6×PD-2 and PD-2×PD-3 crosses was 247.33 and 255.73 eggs, respectively, which was statistically non-significant. The numerical variation might be due to the effect of higher body weight in PD-6×PD-3 cross. Higher ASM than the present findings were observed by Haunshi *et al*. (2009) in Vanaraja (163.14 days), Niranjan *et al*. (2008) in Vanaraja (164.79) and *Gramapriya* (160.89 days), Padhi *et al*. (2016) in 3-way cross (163.14 days). The egg weights at different ages in the present crosses were comparable to the findings of Niranjan *et al*. (2008) and Padhi *et al*. (2016) in rural crosses. Niranjan *et al*. (2008) reported lower annual egg production in rural crosses including *Gramapriya* (237 eggs) and in Vanaraja (150 eggs) than the present results. The egg production was higher in present crosses which makes the bird more suitable for the rural poultry farming adding to the family income.

Table 5. Production performance in terminal crosses involving PD-2 and PD-6 chicken

Trait	n	PD-6×PD-3	n	PD-2×PD-3	Prob.
ASM, days	114	159.02±0.84	110	159.50±1.35	0.749
Egg weight (g)					
28 wks	113	49.25±0.34	108	49.08±0.68	0.808
32 wks	112	51.27±0.40	107	50.58±0.49	0.272
36 wks	112	53.57±0.45	106	53.26±0.45	0.635
40 wks	108	56.47±0.51	106	56.58±0.62	0.891
52 wks	104	58.99±0.59	101	57.39±0.55	0.061
64 wks	98	62.00±0.64	93	60.98±0.69	0.291
72 wks	94	61.67±0.62	89	60.68±0.55	0.261
Egg production (n)					
40 wks	108	90.60±2.47	106	95.18±2.65	0.218
52 wks	104	153.46±3.38	101	158.66±4.12	0.330
64 wks	98	211.32±4.34	93	218.32±4.57	0.280
72 wks	94	247.33±4.81	89	255.73±5.19	0.247

In conclusion, the newly developed PD-6 line was performing on par with the existing PD-2 line as male parent line of *Gramapriya* with an additional advantage of higher body weight during juvenile phase without significantly affecting the other traits. PD-6 line might be a suitable male line for production of *Gramapriya* reducing the complexity of selection program in PD-2 line.

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