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Characterizing grower performance, body conformation and morphology in crosses of RIR and Indian native chicken genotypes

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The exotic Rhode Island Red (RIR) chicken is a well appreciated layer being adapted and acclimatized in backyard system. Aseel and Kadaknath are 2 important Indian native chicken breeds with disease resistance, flavored delicious meat and other breed-specific characteristics (Thakur *et al*. 2006, Chatterjee *et al.* 2007). However, purity of these native chicken breeds is being diluted because of indiscriminate crossbreeding with RIR birds at farmers' field. Moreover, the crossbred progenies are not evaluated for performance, livability and cross-specific characteristics. Hence, the present study was undertaken to characterize the grower performance, body conformation and morphological characteristics in the crosses of RIR females (♀) with Aseel and Kadaknath males (♂) of chicken.

Single hatched out, day-old chicks of RIR♀ × Aseel♂ (50) and RIR♀ × Kadaknath♂ (50) crosses were investigated at the institute for this study. The chicks were wing-banded at the hatchery itself for record keeping and dubbed (beak trimming) to prevent fighting. Thereafter, the chicks were subjected to the brooding into battery brooders with standard floor space and brooding temperature for 4 weeks of age, then shifted into colony house for 16 weeks of age. Freshwater and feed were provided *ad lib.* twice daily. The birds were fed on the institute-formulated chick mash at 0–8 weeks of age followed by grower mash at 9–20 weeks of age (Das *et al.* 2014). The birds were vaccinated following standard vaccination schedule being followed at this institute (Das 2013, Das *et al.* 2014).

The fertility and hatchability records were noted from the incubation registrar of the institute. Chick weights and body weights were measured using digital weigh balance (capacity-0.5 g to 3 kg) to assess grower performance; shank length and keel bone length were measured using vernier calipers, and breast angle using goniometer to assess the body conformation traits at fourth, sixth, eighth, twelfth and sixteenth week of age. The 12 weeks aged each individual bird was investigated for various morphological characteristics through naked eye and by photographing at day-light. The data on the grower performance and body conformation traits were analyzed by least squares analysis of variance (Harvey 1990) taking cross and sex as fixed effects in the linear models.

The chicks were hatched out with the records of 60.31% egg fertility, 51.94% total egg-set basis (TES) hatchability and 86.12% fertile egg-set basis (FES) hatchability in RIR♀ × Aseel♂ cross as like as RIR♀ × CSML broiler♂ cross (CARI-Debendra) (Das 2013). The chicks hatched out in RIR♀ × Kadaknath♂ cross with the records of 66.78% egg fertility, 37.98% TES hatchability and 56.88% FES hatchability estimates varied significantly ($P \leq 0.05$) from the RIR♀ × Aseel♂ cross and exhibited lower performance when compared to other RIR crosses (Das 2013). There was no variation in chicks mortality (2%) recorded in the crosses up to 12 weeks of age and it was an exemplary record when compared to the available earlier reports (Das 2013).

The least squares means of chick weight (CW), body weight (BW), shank length (SL), keel bone length (KL), breast angle (BA) at fourth, sixth, eighth and twelfth week of age in RIR♀ × Aseel♂ and RIR♀ × Kadaknath♂ crosses are presented in Table 1. The present crosses had the chick weight estimates comparable to the RIR selected line/ strain (Das 2013, Das *et al*. 2015a) and better when compared to the crosses of RIR tester cockerels × indigenous lines from Sudan (Bare-neck/Betwil/Large Beladi hens) (Mohammed *et al.* 2005). The present estimates of body weight and conformation traits in the crosses were comparable to RIR selected line (Das *et al*. 2015a) with a bit greater estimates for KL4 and BW8 in RIR♀ × Aseel♂ cross and the body weight estimates were far better than the reports in Aseel

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Table 1. Estimated least squares means of chick weight, grower body weights and body conformation traits in the progenies of RIR♀ × Aseel♂ and RIR♀ × Kadaknath♂ chicken crosses

Factor	N	Least squares means ± standard errors																
		CW (g)	BW4 (g)	SL4 (cm)	KL4 (cm)	BA4 (°)	BW6 (g)	SL6 (cm)	KL6 (cm)	BA6 (°)	BW8 (g)	SL8 (cm)	KL8 (cm)	BA8 (°)	BW12 (g)	SL12 (cm)	KL12 (cm)	BA12 (°)
F_1 Crosses		ns	ns	***	***	***	ns	ns	ns	*	*	**	ns	*	***	***	***	**
RIR♀ × Aseel♂	49	37.84	170.59	3.92	4.83	37.29	321.41	5.63	5.98	41.57	523.18	6.74	6.95	47.24	906.45	8.62	8.69	48.13
		±0.64	±3.78	±0.04^{a}	±0.04^{a}	±0.21^{a}	±7.42	±0.05	±0.06	±0.26^{a}	±12.41^{a}	±0.07^{a}	±0.07	±0.49^{a}	±21.04^{a}	±0.7^{a}	±0.07^{a}	±0.54^{a}
RIR♀ × Kadaknath♂	49	37.42	162.06	3.70	4.45	35.83	311.81	5.64	5.98	40.67	484.09	6.49	6.82	45.56	808.38	8.13	8.29	45.97
		±0.40	±3.42	±0.05^{b}	±0.06^{b}	±0.38^{b}	±7.62	±0.05	±0.05	±0.29^{b}	±10.14^{b}	±0.05^{b}	±0.05	±0.40^{b}	±17.38^{b}	±0.10^{b}	±0.09^{b}	±0.59^{b}
RIR♀ × Aseel♂		ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*	***	**	ns
Male	29	38.65	174.93	3.93	4.79	37.45	324.50	5.71	5.92	41.80	524.29	6.80	6.99	47.65	945.64	8.90	8.91	48.50
		±0.81	±4.83	±0.05	±0.06	±0.27	±9.48	±0.07	±0.07	±0.33	±15.86	±0.08	±0.09	±0.63	±26.88^{a}	±0.09^{a}	±0.9^{a}	±0.69
Female	20	37.03	166.25	3.91	4.88	37.14	318.33	5.56	5.92	41.34	522.08	6.68	6.91	46.83	867.25	8.34	8.47	47.76
		±0.98	±5.82	±0.06	±0.07	±0.33	±11.42	±0.08	±0.09	±0.40	±19.09	±0.10	±0.11	±0.75	±32.37^{b}	±0.11^{b}	±0.11^{b}	±0.83
RIR♀ × Kadaknath♂		ns	ns	ns	ns	ns	*	*	*	ns	***	***	***	***	***	***	***	***
Male	22	38.18	167.05	3.71	4.45	36.00	327.43	5.75	6.16	41.05	526.18	6.70	7.04	47.18	880.45	8.47	8.64	47.68
		±0.59	±5.08	±0.07	±0.10	±0.56	±11.31^{a}	±0.07^{a}	±0.08^{a}	±0.43	±15.05^{a}	±0.08^{a}	±0.08^{a}	±0.60^{a}	±25.80^{a}	±0.14^{a}	±0.13^{a}	±0.88^{a}
Female	27	36.67	157.07	3.69	4.44	35.67	296.19	5.53	5.80	40.30	442.00	6.27	6.60	43.93	736.30	7.79	7.94	44.26
		±0.53	±4.59	±0.07	±0.09	±0.51	±10.21^{b}	±0.06^{b}	±0.07^{b}	±0.39	±13.58^{b}	±0.07^{b}	±0.07^{b}	±0.54^{b}	±23.29^{b}	±0.13^{b}	±0.12^{b}	±0.79^{b}

CW, day old chick weight in grams; BW, SL, KL and BA denote body weight in grams, shank length in centimeter, keel bone length in centimeter and breast angle in degree at different weeks of age, respectively; N, number of observations; ns, nonsignificant ($P \geq 0.05$); *($P \leq 0.05$); **($P \leq 0.01$); ***($P \leq 0.001$); means within a factor and column having different superscripts differ significantly ($P \leq 0.05$).

Table 2. The estimated phenotypic correlations among chick weight, grower body weights and body conformation traits in the progenies of RIR♀ × Aseel♂ (above diagonal) and RIR♀ × Kadaknath♂ (below diagonal) chicken crosses

	CW	BW4	SL4	KL4	BA4	BW6	SL6	KL6	BA6	BW8	SL8	KL8	BA8	BW12	SL12	KL12	BA12
CW		0.384	0.254	0.163	0.035	0.558	0.402	0.420	0.013	0.308	0.175	0.219	0.191	0.310	0.162	0.152	–0.208
BW4	0.252		0.413	0.116	0.330	0.797	0.847	0.801	0.366	0.558	0.475	0.515	0.407	0.631	0.623	0.648	0.009
SL4	0.119	0.246		0.686	0.235	0.304	0.366	0.335	0.273	0.352	0.482	0.529	0.297	0.224	0.346	0.334	0.070
KL4	0.109	0.224	0.867		0.092	0.175	0.177	0.170	0.110	0.171	0.349	0.332	0.183	0.072	0.212	0.187	0.073
BA4	0.016	0.277	0.305	0.303		0.282	0.401	0.268	0.598	0.343	0.400	0.372	0.325	0.134	0.135	0.112	0.223
BW6	0.362	0.690	0.280	0.289	0.430		0.839	0.840	0.314	0.511	0.391	0.416	0.414	0.533	0.455	0.496	–0.080
SL6	0.337	0.701	0.310	0.347	0.432	0.839		0.867	0.426	0.589	0.573	0.569	0.447	0.694	0.681	0.702	–0.026
KL6	0.329	0.647	0.333	0.354	0.335	0.836	0.828		0.464	0.624	0.549	0.630	0.522	0.548	0.544	0.630	–0.017
BA6	0.260	0.363	0.180	0.128	0.407	0.506	0.489	0.492		0.738	0.712	0.691	0.829	0.298	0.290	0.248	0.080
BW8	0.390	0.519	0.134	0.184	0.321	0.745	0.686	0.657	0.628		0.867	0.861	0.858	0.487	0.509	0.428	0.006
SL8	0.393	0.584	0.141	0.179	0.331	0.793	0.805	0.681	0.483	0.845		0.919	0.793	0.348	0.538	0.428	0.022
KL8	0.444	0.510	0.154	0.223	0.235	0.726	0.742	0.750	0.603	0.821	0.844		0.748	0.408	0.544	0.509	0.045
BA8	0.421	0.371	0.182	0.140	0.191	0.616	0.604	0.588	0.769	0.810	0.727	0.805		0.352	0.366	0.320	0.032
BW12	0.165	0.543	0.207	0.223	0.262	0.674	0.631	0.643	0.457	0.646	0.630	0.654	0.532		0.843	0.806	0.011
SL12	0.166	0.539	0.118	0.198	0.322	0.583	0.613	0.563	0.387	0.571	0.601	0.627	0.392	.0811		0.874	0.125
KL12	0.154	0.507	0.111	0.185	0.272	0.630	0.599	0.590	0.363	0.588	0.586	0.632	0.418	0.822	0.918		0.139
BA12	0.017	0.350	–0.055	–0.030	0.197	0.344	0.303	0.265	0.157	0.367	0.391	0.322	0.220	0.483	0.651	0.565	

The number of observations were 49 for each correlation estimate; CW, day-old chick weight in g; BW, SL, KL and BA denote body weight in g, shank length in cm, keel bone length in cm and breast angle in degree at different weeks of age, respectively.

and Kadaknath chicken (Chatterjee *et al.* 2007) wherein body conformation traits were evaluated at 15th week of age and Aseel demonstrated better performances for body weights and conformation traits than the Kadaknath chicken. However, Pakistani varieties of Aseel (Jatoi *et al.* 2014) had higher body weights than the present crosses. But the present body weights were better as evidenced when compared to the crosses of exotic RIR cockerels with Sudanian indigenous lines (Mohammed *et al.* 2005). Whatsoever differences attributed might be due to the general and specific combining ability of different direct and reciprocal crosses of different genetic stocks. The present estimates might also be compared to few earlier reports in the crosses of corresponding genotypes (Mondal *et al.* 2007). The least squares analysis of variance elucidates that the present crosses had significant genotypic differences for body weights at eighth week onwards and most body conformation traits at fourth week onwards with greater estimates in RIR♀ × Aseel♂ cross than the RIR♀ × Kadaknath♂ throughout the age. Mondal *et al.* (2007) also reported RIR × Aseel cross to be better than the Kadaknath × RIR cross. Sex also had significant effect on the body weights and most of the body conformation traits at sixth week onwards in RIR♀ × Kadaknath♂ cross, whereas only on the body weight, shank length and keel bone length at 12th week of age in RIR♀ × Aseel♂ cross. Males were heavier with greater estimates of body weights and conformation traits throughout the crosses and their age in consistence to the available reports (Das *et al.* 2016, 2015a,b, 2014, El-Safty 2012, Singh and Jilani 2005). These findings could indicate that the body weight and conformation of a poultry bird was not sex-independent.

The phenotypic correlations between different grower performance and body conformation traits in the present chicken crosses are presented in Table 2. Most of the correlation coefficients were found positive with lower to higher magnitudes at phenotypic scale except few estimates of breast angle with others throughout the crosses. The intra-week estimates were all positive at higher scale throughout the crosses in accordance to the earlier reports (Das *et al.* 2014, 2015a,b, 2016). The present body weight remained invariably positively correlated with shank length and keel bone length at moderate to higher magnitudes throughout the age and were in consistence with the previous reports (Das *et al*. 2014, 2015a,b, 2016, Singh and Jilani 2005), and thus body weights could predict carcass conformation more accurately. Chick weight also followed the same trend in both the crosses studied.

The present 2 crossbred progenies, when investigated for morphological characteristics at twelfth week of age, showed qualitatively different colours of shank, skin, beak, comb, earlobe, eye (iris), wattle, body plumage along with its pattern, comb type and pattern within feather; whereas feather distribution and morphology were qualitatively indifferent between the crosses (Table 3). The RIR♀ × Aseel♂ cross progeny also demonstrated qualitatively different colours for comb, earlobe, upper part of beak, and presence of wattle for male and female birds; whereas the RIR♀ × Kadaknath♂ cross progeny had qualitatively different body plumage and shank colour, presence of wattle and pattern within feather for males and females (Table 3).

The major morphological characteristics in the crosses were seemingly inherited from the parental Aseel and Kadaknath chicken, and so the crosses with same parental RIR (dam) had qualitatively different morphology attributed due to the differential pigmentations. The morphological reports in these present crosses were lacking, but still the present information might serve as the cross characteristics of RIR♀ × Aseel♂ and RIR♀ × Kadaknath♂ chicken crosses.

Table 3. Morphological characteristics observed in 12 weeks aged progenies of RIR♀ × Aseel♂ and RIR♀ × Kadaknath♂ chicken crosses

Morphological characteristic	RIR♀ × Aseel♂ cross progeny		RIR♀ × Kadaknath♂ cross progeny	
	Male	Female	Male	Female
Shank colour	Light yellow	Light yellow	Leaden blue/ slate	Black
Skin colour	Whitish	Whitish	Blackish	Blackish
Beak colour	Upper- Blackish red Lower- Yellowish	Upper- Redish yellow Lower- Yellowish	Black	Black
Comb type	Single serrated	Single serrated	Pea	Pea
Comb colour	Light red	Redish white	Redish black	Redish black
Wattle colour and size	Light red and small	Not distinct	Redish black and small	Not distinct
Earlobe colour	Redish white	White	Blackish	Blackish
Eye (iris) colour	Green	Green	Brown	Brown
Body plumage colour	Buff (medium shade of orange-yellow with a rich gold cast)	Buff (medium shade of orange-yellow with a rich gold cast)	Bluish slate (bluish dark gray ground colour with yellow patches/smears)	Dark slate (very dark bluish gray approaching black)
Plumage pattern	Solid	Solid	Non-specific	Non-specific
Pattern within feather	Self-buff	Self-buff	Non-specific	Laced
Feather morphology	Normal	Normal	Normal	Normal
Feather distribution	Normal	Normal	Normal	Normal

SUMMARY

The day-old chicks of RIR♀ × Aseel♂ and RIR♀ × Kadaknath♂ crosses were investigated to characterize their grower performance, body conformation and morphological characteristics. The progeny of RIR♀ × Aseel♂ cross exhibited heavier body weights and greater estimates of body conformation traits throughout the age than in the RIR♀ × Kadaknath♂ cross with significant sex-differences and lower to higher range of phenotypic correlations at positive direction among the traits. Both the crosses also exhibited different colours of shank, skin, beak, comb, eye, earlobe, wattle, body plumage along with its pattern, comb type and pattern within feather with sex differences for some characteristics when observed their progenies at 12th week of age. These cross specific findings might serve as the cross identification earmarks.

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