Indian Journal of Animal Sciences **84** (9): 986–991, September 2014/Article

Assessment of body conformation, feed efficiency and morphological characteristics in Rhode Island Red-White strain chicken*

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Received: 25 March 2014; Accepted: 9 May 2014

ABSTRACT

This investigation aimed to assess body conformation, feed efficiency and morphological characteristics in RIR-White strain chicken of which 73 single hatched chicks were investigated at CARI, Izatnagar. Data were analyzed by least squares analysis of variance. Least squares (LS) means of chick weight, body weights at 4th, 6th, 8th, 12th and 16th weeks were estimated. Corresponding LS means of shank length, keel length and breast angle at 4th, 6th, 8th, 12th and 16th week of age, and of body weight gain, feed consumed and FCR were estimated. Sex had effect significant on body conformation traits and weight gain at the age of 8th week onwards and on FCR at 8th and 16th weeks. Phenotypic correlations among intra-week body conformation traits were positively high throughout the ages. Pattern within feather was self-white with normal feather morphology and solid white plumage, yellow skin and shank, and red single comb. The strain laid brown eggs. This might serve as strain characteristics of this rare strain of RIR chicken.

Key words: Body conformation traits, Correlation, Feed efficiency, Genetic and non-genetic factors, Morphology, RIR White strain chicken

A rare white colored strain of RIR chicken evolved at CARI, Izatnagar, was institutionally named as RIR-White strain. It is a brown egg layer chicken but still has not been characterized. General belief is that consumers prefer a plump-breasted bird because of a preference for white meat. With the increasing popularity of cut-up chicken, processors believe that a plump-breasted bird yields a greater percentage of breast meat than do birds with a less plump breast. The desires of the consumer and processor are reflected back to the breeder, with the result that one more character may have to be added to the many already in his selection program (Newell *et al.* 1954). Measurements of body dimensions of the live chicken effectively predict body size and compactness components. The body size component, best predicted by trunk length, is highly correlated with body weight; the compactness component is best predicted by breast angle and either breast depth or shank thickness. Body dimensions could therefore be used to predict either conformation or percentage meat yield of the broiler carcass if suitable correlations can be demonstrated (Reid *et al.* 1984). The best way to improve the productivity of any low performance chicken without altering any of the morphological characteristics is to select for production traits within a given population. Such strategy needs accurate estimates of genetic and phenotypic parameters.

Keeping all this background information, the present investigation was carried out to assess body conformation and feed utilization efficiency statistics and morphological characteristics in RIR-White strain, a rare strain of RIR.

MATERIALS AND METHODS

Experimental birds and procedures: Single hatched out non-pedigreed day-old chicks (73) RIR-White strain chicken maintained at the Experimental Layer Farm of Central Avian Research Institute (CARI), Izatnagar (UP) were investigated for the study on body conformation, feed utilization efficiency and morphological characteristics.

Poultry husbandry adopted: The RIR-White strain was maintained by random mating the parental RIR-White strain female lines in individual laying cages artificially inseminating pooled semen collected from the sires of RIR-White strain and selected for egg production up to 40 weeks of age along with some independent culling for egg weights

*Part of the Ph.D. Thesis (2013) of first author, Indian Veterinary Research Institute (Deemed University), Izatnagar.

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at 28th and 40th week of age. Initial vaccination was done in the hatchery itself at day-old stage, before transferring on to the litter brooder having adjustable hover fitted with single infrared lamp of 250 watt. Standard floor space and brooding temperature were provided. Chicks were provided with continuous light for 24 h in the first 3 weeks, which was decreased @ 2 h/week until 8 weeks. After attaining the 4 weeks of age the chicks were shifted into new brooder house or colony house for 16 weeks. Female birds were shifted into cages for breeding, laying and pedigree maintenance. Feed and water was provided *ad lib.* Twice daily. Birds were fed on CARI-formulated (Division of Avian Nutrition & Feed Technology) chick mash with CP–20.65%, ME-2694.64 Kcal/kg, Calcium-1.02%, Available phosphorous–0.45%, lysine-1.05% and methionine-0.41% for 0–8 weeks of age, grower mash with CP-16.78%, ME-2536.00 Kcal/kg, Cal-1.15%, P-0.40%, Lys-0.76% and Met-0.37% for 9–20 weeks and layer mash with CP-18.18%, ME-2676.52 Kcal/kg, Cal-3.61%, P-0.34%, Lys-0.83% and Met-0.36% for 20 weeks onwards. Chicks were vaccinated following standard vaccination programme being followed at this Institute, viz. vaccination for Ranikhet and Marck's diseases at day-old, IBD on 14-day, RD booster on 28-day, IBD booster on 35-day and fowl pox at 42–day of age.

Traits investigated

Body weight and body conformation traits: Body weight (BW), shank length (SL), keel length (KL) and breast angle (BA) at 4th (BW4, SL4, KL4, BA4), 6th (BW6, SL6, KL6, BA6), 8th (BW8, SL8, KL8, BA8), 12th (BW12, SL12, KL12, BA12) and 16th (BW16, SL16, KL16, BA16) weeks of age were measured using digital weigh balance for BW, vernier calipers for SL & KL and goniometer/ breastometer for BA-measurements.

Feed consumption and efficiency traits: Feeding trials (*ad lib.*) were conducted from day-1 to 16th weeks of age on the basis of separate colony housing covering day-1 to 4 weeks in battery brooding shelves and from 5 to16 weeks on litter at new brooder houses crucially maintaining four subgroups under 2 feeding groups. The birds were provided with weighed quantity of standard ration i.e. starter and grower feed for day-1 to 8th weeks, 9th to 16th weeks of age respectively. Feeding was done twice daily in morning and evening with all possible measures adopted to reduce wastage of feed. The feed residue was weighed after each recording period, followed by notice of any mortality on specific date, if any, the dead bird's(s') wing band number(s) and weight were date-wise recorded and the amount of feed consumed by individual birds/ day was calculated. Feed consumption and efficiency was expressed as feed consumed/intake (g), live body weight gain (g) and feed conversion ratio (FCR) / feed efficiency (g feed intake/ g weight gain) in different periods of ages (weeks).

Morphological traits: Individual bird of both sexes were investigated at 20 weeks of age for feather and plumage characteristics, colour of skin, shank, earlobe, comb, wattle and also of egg, comb type as well.

Statistical treatments and analysis: Data on chick weight, body weights, body conformation traits and feed utilization efficiency traits of RIR-White strain chicken was analyzed by least squares analysis of variance (Harvey 1990) incorporating sex and or feeding groups (where applicable) as fixed effects in the statistical model:

$$Y_{ijk} = \mu + S_i + H_j + e_{ijk};$$

where, Y, value of a trait measured on ijkth individual; μ, overall mean; S_i, fixed effect of ith sex; H_j, fixed effect of jth feeding group; and e_{ijk}, random error associated with mean 0 and variance σ^2. Phenotypic parameters of various body weights and body conformation traits were estimated by least squares ANOVA.

RESULTS AND DISCUSSION

Chick weight and body weights: Least squares means of chick weight, body weights at 4th, 6th, 8th, 12th and 16th weeks are given in Table 2. The present chick weight was comparable to the earlier reports for RIR chicks of Ashraf *et al.* (2003) (36.66 g), and Das (2013) (34.35±0.15 to 37.50±0.11 g for RIR control to selected lines), but better than the report (30.12±2.86 g) in RIR chicks (Malago and Baitilwake 2009). The present estimates of body weights at 4 to 16th wk were significantly better than RIR control line but lower ($P<0.05$) than RIR selected line (Das 2013). The present chicken strain also performed better than indigenous chicken breed or its cross with RIR chicken as evident when compared to the earlier available reports for Kadaknath and Aseel chickens at 12th wk, excepting for 16th wk body weight of 1,218±19.0 g (Chatterjee *et al.* 2007), RIR × indigenous lines Bare-neck/ Betwil/ Large Beladi crosses (Mohammed *et al.* 2005), Fayoumi (Fy) male × RIR female cross and its reciprocal (El-Maghraby *et al.* 1975). Difference might be due to strain, line or breed difference and different management as well as rearing system.

Body conformation traits: Corresponding estimates for least squares means of shank length (SL), keel length (KL) and breast angle (BA) and the BC traits measured at 4th and 6th weeks of age showed nonsignificantly higher estimates for males than females, whereas 8th week onwards BC traits demonstrated significant higher estimates for males than females.

The present results might be compared to the earlier reports of least squares means for shank length in WLH and Giriraja, for keel length in WLH with significantly pooled higher records for both the traits in male for 12 wks onwards (Adebambo *et al.* 2006); in Libyan native chicken (El-Safty 2012) and Belgium's most ancient Ardennaise chickeni breed (Lariviere *et al.* 2009) for shank length and keel angle; and Kadaknath and Aseel for shank length, keel length and breast angle respectively (Chatterjee *et al.* 2007). Difference might be due to strain, line or breed difference and different management as well as rearing system.

Feed utilization and efficiency traits: Corresponding least squares means of live body weight gain, feed consumed and feed conversion ratio are given in Table 2. Lariviere *et*

Table 1. Least squares analysis of variance of various body conformation traits in RIR-White strain chicken

Source of variation	df	Mean sum of squares																				
		CW	BW4	SL4	KL4	BA4	BW6	SL6	KL6	BA6	BW8	SL8	KL8	BA8	BW12	SL12	KL12	BA12	BW16	SL16	KL16	BA16
Sex	1	8.3	232.1	0.003	0.007	1.01	7109.7	0.14	0.85	25.6	5.0^{E+04}*	1.2*	1.5*	57.8*	2.1^{E+05}**	4.2**	3.2**	79.3***	1.1^{E+06}***	19.8***	7.7***	171.7***
Remainder	71	10.0	1352.9	0.15	0.11	5.7	3193.4	0.18	0.25	8.4	9146.7	0.3	0.3	11.1	2.6^{E+04}	0.4	0.4	6.6	4.4^{E+05}	0.5	0.6	9.5
			(42)	(42)	(42)	(42)	(67)	(67)	(67)	(1)	(67)	(67)	(67)	(67)	(67)	(67)	(67)	(67)	(66)	(66)	(66)	(66)

* P<0.05, ** P<0.01, *** P<0.001; Figures within parenthesis denote degrees of freedom (df); CW, BW, SL, KL and BA denote chick weight, body weight in grams, shank length in cm, keel length in cm and breast angle in degree at different periods of ages in weeks, respectively.

Table 2. Least squares means±standard errors of various body conformation traits in RIR-White strain chicken

Factors	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 (°)	BW16 (g)	SL16 (cm)	KL16 (cm)	BA16 (°)
Overall	35.91	190.26	4.23	4.49	36.45	322.85	5.77	5.85	41.38	482.43±	6.65	7.00	49.64	828.75	8.39	8.50	52.76	1206.07	9.70	9.85	55.76
	±0.37	±5.57	±0.06	±0.05	±0.36	±6.82	±0.05	±0.06	±0.35	11.54	±0.06	±0.07	±0.40	±19.35	±0.08	±0.08	±0.31	±25.47	±0.08	±0.09	±0.38
	(73)	(44)	(44)	(44)	(44)	(69)	(69)	(69)	(69)	(69)	(69)	(69)	(69)	(69)	(69)	(69)	(69)	(68)	(68)	(68)	(68)
Sex																					
Male	35.58	192.56	4.24	4.50	36.60	333.03	5.81	5.96	41.99	509.46	6.78	7.15	50.55	884.62	8.64	8.72	53.84	1333.11	10.2	10.19	57.35
	±0.51	±7.51	±0.08	±0.07	±0.49	±9.29	±0.07	±0.08	±0.48	±15.72^{a}	±0.08^{a}	±0.09^{a}	±0.55^{a}	±26.36^{a}	±0.11^{a}	±0.11^{a}	±0.42^{a}	±34.39^{a}	±0.11^{a}	±0.12^{a}	±0.51^{a}
	(39)	(24)	(24)	(24)	(24)	(37)	(37)	(37)	(37)	(37)	(37)	(37)	(37)	(37)	(37)	(37)	(37)	(37)	(37)	(37)	(37)
Female	36.25	187.95	4.23	4.48	36.30	312.67	5.72	5.74	40.77	455.41	6.51	6.85	48.72	772.88	8.15	8.29	51.69	1079.03	9.16	9.52	54.16
	±0.54	±8.23	±0.09	±0.08	±0.54	±9.99	±0.08	±0.09	±0.51	±16.91^{b}	±0.09^{b}	±0.10^{b}	±0.59^{b}	±28.35^{b}	±0.11^{b}	±0.12^{b}	±0.46^{b}	±37.57^{b}	±0.12^{b}	±0.13^{b}	±0.55^{b}
	(34)	(20)	(20)	(20)	(20)	(32)	(32)	(32)	(32)	(32)	(32)	(32)	(32)	(32)	(32)	(32)	(32)	(31)	(31)	(31)	(31)

Figures within parenthesis denote number of observations; CW, BW, SL, KL and BA denote chick weight, body weight in grams, shank length in cm, keel length in cm and breast angle in degree at different periods of ages in weeks, respectively.

Table 3. Least squares analysis of variance of various feed utilization and efficiency traits in RIR-White strain chicken

Source of variation	df	Mean sum of squares														
		WG4	FC4	FCR4	WG6	FC6	FCR6	WG8	FC8	FCR8	WG12	FC12	FCR12	WG16	FC16	FCR16
Feeding group	1	0.22	18582.1***	0.714	373.27	25951.9***	0.62	205.47	50765.5***	0.83	38109.0$^{\#}$	138100.4***	126.11	3367.08	1.38454.8***	2.39
Sex	1	1731.7	36.06	0.31	1333.11	46.81	0.82	22436.3*	544.66	22.9*	71125.2*	219.34	6.48	305800.9***	2549.6$^{\#}$	53.2***
Remainder	63	1224.9	78.94	0.39	1373.77	349.68	2.69	3615.65	453.08	3.58	10721.8	477.59	82.42	9445.72	679.58	1.92

$^{\#}$ P<0.06, * P<0.05, *** P<0.001: WG, FC and FCR denote live body weight gain in grams, feed consumed in grams and feed conversion ratio at different periods of ages in weeks, respectively.

al. (2009) evaluated feed conversion ratio (FCR) in Ardennaise. Mahrous *et al.* (2008) reported body weight gain in 4 genetic groups of feathered, frizzled, naked neck and naked neck-frizzled chickens. Mengesha (2012) reviewed average feed conversion ratio as 7.0 and 4.2 at 8th and 12th weeks of age of some indigenous chicken in intensive rearing system and 3.04 and 5.6 at 12th week of age in semi-intensive rearing system in some indigenous chicken in the tropical countries of Africa.

Genetic and non-genetic factors affecting various quantitative traits

Influences of sex: Sex had significant effect on body weights from 8-week onwards; males being heavier than females throughout the ages. Sex also initiated its significant ($P<0.05$) effect on all body conformation traits and one of the feed efficiency traits i.e. live body weight gain at eighth week of ages onwards; males being better than females throughout the ages. FCR was also affected ($P<0.05$) by sex at 8th and 16th weeks of age, FCR for male birds being better than that of females throughout the ages.

Significant sex-differentiation in body weights and males being heavier than females was also observed at sixth week onwards in native Libyan chicken (El-Safty 2012), at eighth week body weight in White Plymouth Rock chickens (Siegel 1962), and at 12 weeks onwards in Giriraja, Indian WLH, and Nigerian improved indigenous chicken genotypes (F_1, F_2 and B-á chickens) (Adebambo *et al.* 2006). Body conformation traits viz. breast girth, shank length and keel length not to be all significantly affected by sex excepting shank length for 12th, 15th and 18th weeks of ages in Giriraja, Indian WLH, and Nigerian improved indigenous chicken genotypes (F_1, F_2 and B-á chickens) (Adebambo *et al.* 2006). Lariviere *et al*. (2009) reported that keel angle and keel length were all greater in males and significantly different between sexes ($P<0.001$) at 85 days in Belgium's most ancient Ardennaise chicken breed. El-Safty (2012) reported that males had significantly greater values for keel and shank lengths of Libyan native chickens at different ages when compared with female counterparts. Siegel (1962) reported significant sex and line effects for the body weight and breast angle at 8 weeks of age in 2 sub populations of White Plymouth Rock chickens. Sex-influence on feed efficiency traits had no available reference to draw inference.

Influence of feeding groups: Feed utilization criteria i.e. feed consumed (FC) in grams significantly varied among the feeding groups throughout the periods of ages and so somewhere it was near to affect also the body weight gain. Literature could not be made available to draw inference.

Phenotypic correlations of various body conformation traits: Phenotypic correlations coefficients (Table 5) were also found to be all positive and extreme high in magnitude uniformly among all the intra week body conformation traits. Body weight invariably remained positively and phenotypically correlated with shank length, keel length and breast angle throughout all intra-week body

Table 4. Least squares means±standard errors of various feed utilization and efficiency traits in RIR-White strain chicken

		Least squares means±standard errors												
Factors	Obs	WG4(g)	FC4(g)	FCR4	WG6(g)	FC6(g)	FCR6	WG8(g)	FC8(g)	FCR8	WG12(g)	FC12(g)	FCR12	WG16(g)	FC16(g)	FCR16
Overall	66	152.49	420.91	2.89	134.71	528.76	4.30	158.06	628.54	4.61	346.71	1650.73	6.33	379.83	1782.21	5.17
		±4.33	±1.10	±0.08	±4.58	±2.31	±0.20	±7.44	±2.63	±0.23	±12.81	±2.70	±1.12	±12.02	±3.22	±0.17
Feeding group	1 34	152.55	437.71	3.0013	7.09	548.61	4.39	156.29	656.30	4.73	370.77	1696.52	4.94	372.68	1828.06	5.36
		±6.01	±1.53^b	±0.11	±6.36	±3.21^b	±0.28	±10.32	±3.65^b	±0.32	±17.77	±3.75^b	±1.56	±16.68	±4.47^b	±0.24
	2 32	152.43	404.12	2.79	132.33	508.91	4.20	159.83	600.78	4.50	322.66	1604.94	7.71	386.98	1736.36	4.98
		±6.21	±1.58^a	±0.11	±6.58	±3.32^a	±0.29	±10.67	±3.78^a	±0.34	±18.37	±3.88^a	±1.61	±17.25	±4.63^a	±0.25
Sex																
Male	36	157.64	421.66	2.83	139.22	529.61	4.18	176.58	631.43	4.02	379.69	1652.56	6.01	448.22	1788.45	4.26
		±5.83	±1.48	±0.10	±6.18	±3.12	±0.27	±10.02^a	±3.55	±0.32^a	±17.26^a	±3.64	±1.66	±16.20^a	±4.34	±0.23^a
Female	30	147.35	420.17	2.96	130.19	527.91	4.41	139.53	625.65	5.21	313.73	1648.90	6.64	311.44	1775.96	6.07
		±6.39	±1.62	±0.11	±6.77	±3.42	±0.30	±10.99^b	±3.89	±0.35^b	±18.92^b	±3.99	±1.51	±17.76^b	±4.76	±0.25^b

WG, FC and FCR denote live body weight gain in grams, feed consumed in grams and feed conversion ratio at different periods of ages in weeks, respectively; Means within a factor having different superscripts differ significantly ($P<0.05$).

Table 5. Phenotypic correlations among intra-week various body conformation traits in RIR-White strain chicken

Traits	BW4	SL4	KL4
SL4	0.6864 (44)		
KL4	0.6806 (44)	0.8763 (44)	
BA4	0.9070 (44)	0.5917 (44)	0.6037 (44)
Traits	BW8	SL8	KL8
SL8	0.7942 (69)		
KL8	0.8025(69)	0.8785(69)	
BA8	0.8789(69)	0.7245(69)	0.7272(69)
Traits	BW16	SL16	KL16
SL16	0.8933 (68)		
KL16	0.8690(68)	0.8615(68)	
BA16	0.9314(68)	0.8340(68)	0.8167(68)
Traits	BW6	SL6	KL6
SL6	0.8089 (69)		
KL6	0.7938(69)	0.7822(69)	
BA6	0.9181(69)	0.7497(69)	0.7230(69)
Traits	BW12	SL12	KL12
SL12	0.9185 (69)		
KL12	0.8710(69)	0.8483(69)	
BA12	0.8926(69)	0.8751(69)	0.8132(69)

Figures within parenthesis denote number of observations.

conformation traits. Siegel (1962) suggested that phenotypic correlations were influenced by the magnitude and signs of the genetic and environmental correlations, it was of interest to compare these values with each other and to make comparisons of each within and between subpopulations of breast angle (A) and body weight (W) studied in White Plymouth Rock chickens at 8 weeks of age. Adebambo *et al.* (2006) found the phenotypic correlations among body measurement parameters were generally lower at older ages than at younger ages in Giriraja, Indian WLH, and Nigerian improved indigenous chicken genotypes (F_1, F_2 and B-á chickens). Lariviere *et al.* (2009) found keel angle and keel length to be associated with body weights in Belgium's most ancient Ardennaise chicken breed. Banerjee (2010) found body weight and breast angle of Vigova Super M broiler ducks to be positively and significantly correlated at all age groups of 21, 28, 35, 42, 49 and 56 days of age.

Morphological characteristics

Feather characteristics: Its feather morphology and feather distribution was normal, and feather growth was found fast. Pattern within feather was self-white in both the sexes.

Plumage characteristics: Plumage colour was off-white in chicks and white in adult birds. Plumage pattern was solid with rust stinge on back in adult male whereas solid with rust stinge on neck region in adult female birds.

Other characteristics of adult birds: Colour of skin and shank was yellow of both the sexes. Colour of earlobe, comb and wattle was red and eyes were grey or brown in colour in both the sexes. Comb was single in type with size of large in male and medium in female. Wattle size was large in male and small in female. Egg colour was brown.

This white strain of RIR chicken and so its morphological characteristics could not be made available in literature till date.

It is concluded that these assessed characteristics in RIR-White strain developed and maintained at CARI, Izatnagar (UP) might serve as strain documents of this rare strain of RIR chicken and might be helpful in selection programme for its improvement.

ACKNOWLEDGEMENTS

The authors wish to sincerely thank IVRI, Izatnagar for providing the IVRI-Senior Research Fellowship to the first author for pursuing his Ph.D. programme at IVRI-Deemed University. The Director, CARI, Izatnagar and Head, Avian Genetics and Breeding Division, CARI are gratefully acknowledged for providing the necessary facilities for this work.

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