The Pharma Innovation Journal 2019; 8(11): 258-263

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2019; 8(11): 258-263

www.thepharmajournal.com
Received: 07-09-2019
Accepted: 09-10-2019

Soubhagya Muduli
Post-Graduation, Department of Poultry Science, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

NC Behura
Post-Graduation, Department of Poultry Science, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

L Samal
Post-Graduation, Department of Poultry Science, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

Jessy Bagh
Department of Livestock Production and Management,

Abhijeet Champati
Post-Graduation, Department of Poultry Science, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

HK Popalghat
Post-Graduation, Department of Poultry Science, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

Corresponding Author:
Soubhagya Muduli
Post-Graduation, Department of Poultry Science, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

Juvenile growth, efficiency and phenotypic correlation of body weight and growth traits of native *Nusuri* × broiler crosses under intensive management system

Soubhagya Muduli, NC Behura, L Samal, Jessy Bagh, Abhijeet Champati and HK Popalghat

Abstract
A study was conducted to evaluate the performance of Native *Nusuri* × Broiler chicks up to 8 weeks of age under intensive system of rearing. Hundred eight (108) day old chicks from a single hatch were divided into three replicate groups of 36 each. Body weights (BW) of all birds were recorded at day-one and at weekly interval up to 8 weeks. The feed consumption was recorded replicate wise on weekly basis. Mortality was recorded daily replicate wise. Linear body measurements were recorded at 8th week of age. The body weight of male and female chicks at 0 day was 39.28 ± 0.25g and 38.91 ± 0.14g and the 8th week body weight was 996.17 ± 1.16g and 790.44 ± 3.74g respectively. In male chicks, the weekly body weight gain was significantly (p<0.05) higher at all (1st to 8th) age compared to female chicks. The weekly body weight gain increased with increase in age up to 6th week and there after declined. Highest weekly weight gain was observed during 6th week in both male chicks (218.22±1.44g) and female chicks (160.00±0.54g). During 1st week, the FCR and FCE of Native *Nusuri* × Broiler cross chicks were 1.43±0.02 and 0.70±0.003 respectively. At 8th week, the weekly FCR and FCE values were 2.51±0.13 and 0.40±0.006 respectively. The weekly FCR values increased with advancement of age while the FCE values decreased. At 8th week, the cumulative FCR and FCE values were 1.96±0.06 and 0.40±0.006 respectively. The keel length of males (8.51±0.07cm) was significantly (p≤0.01) higher than those of females (8.05±0.04cm). The body length of males was 31.22±0.34cm, which is significantly (p≤0.05) higher than those of female (29.39±0.32cm). The breast angle of males was found to be 39.21±0.42° which was significantly (p<0.01) than those of females with a mean value of 32.50±0.25°.

Keywords: Growth performance, linear body measurement, correlation, native *nusuri* × broiler crosses, poultry

Introduction
Backyard poultry sector plays a significant role in improving the socio-economic status of rural people by generating employment opportunity and augmenting family income particularly among landless labourers, small and marginal farmers and women in rural areas. The native chickens are highly adapted to the local climatic conditions and are highly resistant to adverse climate and endemic diseases (Padhi, 2016) [17]. Comparatively, little research and development work has been carried out on rural poultry, despite the fact that they are usually more numerous than the commercial chickens in most developing countries (Cumming, 1992) [4]. However, the local chickens are poor performers when compared to improved commercial chicken varieties. In order to increase the productivity of backyard chicken, introducing improved low technology inputs birds are necessary. To utilize the good adaptive characteristics of the indigenous chickens and possibly exploit the phenomenon of heterosis or hybrid vigour, crossbreeding programmes of local chickens with suitable exotic stocks would be more appreciable. Crossbreeding could lead to production of birds that will be better in growth rate, efficiency of feed conversion and production traits without sacrificing adaptability to the local environment (Adebambo *et al*., 2011) [1]. Poultry meat is considered as nutrient dense food which is desirable in planning health diets (Kondaiah *et al*., 2002) [13]. It is playing an important role in providing nutritious diet to consumers with high protein and low-fat level and universal acceptability without any taboo. Considering the necessity to develop potential poultry crossbreds, suitable for backyard farming as well as commercial farming, the present study is undertaken to evaluate the growth, efficiency and body conformation traits of Native *Nusuri* X Broiler crossbred chicks up to 8th week of age.

Materials and methods

Study area

The experiments were conducted in the in the Post Graduate Department of Poultry Science under the Faculty of Veterinary Science and Animal Husbandry, Orissa University of Agriculture and Technology, Bhubaneswar. Female Broiler breeders birds of synthetic dam (CSFL) maintained under All India Coordinated Research Project on Poultry Breeding", and a native chicken population from Mayurbhanj district of Odisha, maintained separately were used for the study.

Experimental birds and protocol design

Adult native Nusuri cocks and Coloured synthetic Broiler Female Line (CSFL) hens at the age of 40 weeks were housed in breeding pens in the ratio 1:6 to obtain the hatching. The eggs were hatched to obtain day old chicks for the study. Hundred eight (108) day old chicks from a single hatch were divided into three replicate groups of 36 each. All the chicks were wing banded. Routine medication procedures were followed for all the experimental chicks. All the chicks were immunized against Marek's disease on 1st day, Ranikhet disease (RD) on 5th and 28th day using LaSota strain, infectious bursal disease (IBD) on 14th and 35th day, fowl pox on 42nd day and RD using R_2B strain at 8th week. An experimental chick diet was prepared and fed to the chicks *ad libitum*. Clean and fresh water was made available at all times. The experimental diets were analyzed for proximate composition according to AOAC (2000). Calcium was determined according to the modified method of Talapatra *et al*. (1940) and available phosphorus was determined spectrophotometrically adopting the metavanadate method. The gross and proximate compositions of the experimental diets are presented in Table 1.

Table 1: Gross and chemical composition of experimental chick diet

Gross composition		Chemical composition (% on DM basis)	
Ingredient	**Quantity (%)**	**Nutrient**	**Conc. (%)**
Maize	60	Moisture	9.23
Soya bean meal	30	Crude protein	19.98
De-oiled rice bran	7	Ether extract	4.14
Mineral mixture	3	Crude fibre	4.22
Common salt	0.3	Total ash	9.43
Trace mineral	0.1	Acid insoluble ash	2.6
Vitamin premix	0.3	Nitrogen free extract	62.23
Choline chloride	0.05	Calcium	0.90
Anti-coccidial	0.05	Available phosphorus	0.45
Toxin binder	0.02	Metabolizable Energy*	2850 kcal/kg

*Calculated value

Body weight (BW) of all birds was recorded at day-one and at weekly interval up to 8 weeks. The BW gain for a particular week was calculated by subtracting the BW of previous week from the recorded BW of current week. Weekly cumulative BW was calculated by subtracting the day-old BW from the BW of the respective week. The feed intake was recorded replicate-wise on weekly basis by subtracting the left over feed at the end of the week from the total feed offered during the week. Cumulative feed consumption was calculated by adding the feed consumption from 1st week up to the desired week. From the weekly BW gain and feed consumption, weekly feed conversion ratio (FCR) was calculated. Cumulative FCR was calculated from cumulative BW gain and cumulative feed intake. Mortality of the chicks was recorded daily replicate-wise. Various linear body measurements such as breast angle, shank length, shank width, body length, height, and girth and keel length were measured in at 8th week of age with electronic digital calipers as described below.

Breast angle: It was recorded with the help of a breast meter to the nearest of one degree accuracy. For measuring the breast angle, the apparatus was placed posterior to the anterior edge of keel bone.

Shank length: It was measured from top of the hock joint to toe.

Shank width: It was measured at the centre between the hock joint and carpal joint.

Body length: It was recorded from the tip of the beak to the tip of the tail with the help of a measuring tape to the nearest of 1 cm accuracy.

Height of the bird: It was recorded from the tip of the beak to the tip of the middle toe with the help of a measuring tape to the nearest of 1 cm accuracy.

Body girth: It was measured at the centre of the girth region with the help of measuring tape to the nearest of 1 cm accuracy.

Keel length: It was recorded as the distance between the anterior end of keel bone and the point of keel (posterior end of keel bone) with the help of measuring tape to the nearest of 1cm accuracy.

Data analysis

Data were subjected to analysis of variance and the treatment means were separated by Duncan's test using SPSS 17.0 (SPSS Inc., Chicago, IL, USA).Significance was declared at $P \leq 0.05$.

Results and discussion

Body weight and Body Weight Gain

The mean weekly body weights of Native *Nusuri* × Broiler cross chicks from 0 to 8 weeks of age; sexes separated and combined sex wise, are presented in Figure 1. The mean day-old body weight of experimental birds in present experiment was found to be 39.00 ± 0.12g.The day old body weight of various broiler native crosses reported by Kalita *et al*. (2011) [11], Padhi *et al*. (2014) [15], AICRP centre, BAU Ranchi and AICRP centre, AAU Gauhati (Anonymous, 2016) were 29.65g, 32.67g, 29.09g and 31.5g respectively. The day old body weight of broiler native crosses as reported above were lower than the day old body weight of Native *Nusuri* X Broiler cross under study. However the day-old body weight of Native *Nusuri* × Broiler crosses in present experiment was lower than the crosses of PD1 × PD4 (43.07 ± 0.042g) as reported by Padhi *et al*. (2014) [15]. The higher day old body weight of PD1 × PD4 crosses could be due to the fact that two meat type chicken were used for developing the said cross.

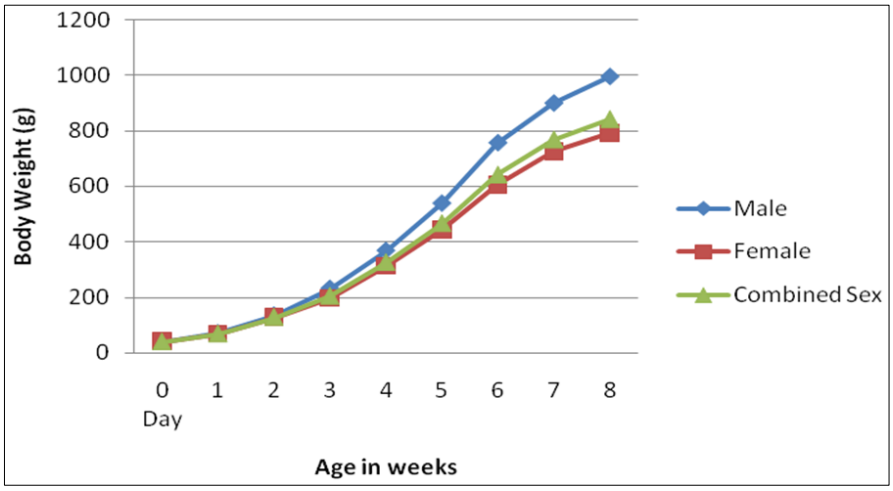

Fig 1: Mean weekly body weights of Native *Nusuri* × Broiler cross chicks

The day-old body weight of Native *Nusuri* × Broiler crosses obtained in this experiment was similar to that of Van raja (39.91 ± 0.28g), a dual type chicken variety as reported by Jha *et al.* (2012) [12]. The 8th week body weight of cross under study on the basis of combined sex was 841.16 ± 10.82g. As reported by Adedokun and Sonaiya (2002), Chaterjee *et al.* (2002) [3], Kalita *et al.* (2011) [11], Jha *et al.* (2013) and Padhi *et al.* (2015) [16] the 8th week body weight of various broiler native crosses were 468 ± 33.1g, 413 ± 8.12g, 670.83g, 478.23 ± 2.32g and 721.73 ± 15.20g respectively. It is found that the 8th week body weight of experimental birds were almost double of the values as reported by various workers previously at same age. Sex separated and combined sex wise weekly body weight gain of Native *Nusuri* × Broiler cross chicks from 0 to 8 weeks of age has been depicted graphically in Figure 2. In male chicks, the weekly body weight gain was significantly (p<0.05) higher at all (1st to 8th) age compared to female chicks. The weekly body weight gain increased with increase in age up to 6th week and there after declined. Highest weekly weight gain was observed during 6th week in both male chicks (218.22±1.44g) and female chicks (160.00±0.54g). The combined sex wise weekly body weight gain of Native *Nusuri* × Broiler cross chicks at 1st and 8th week of age was 28.13±0.37g and 73.62±1.65g respectively.

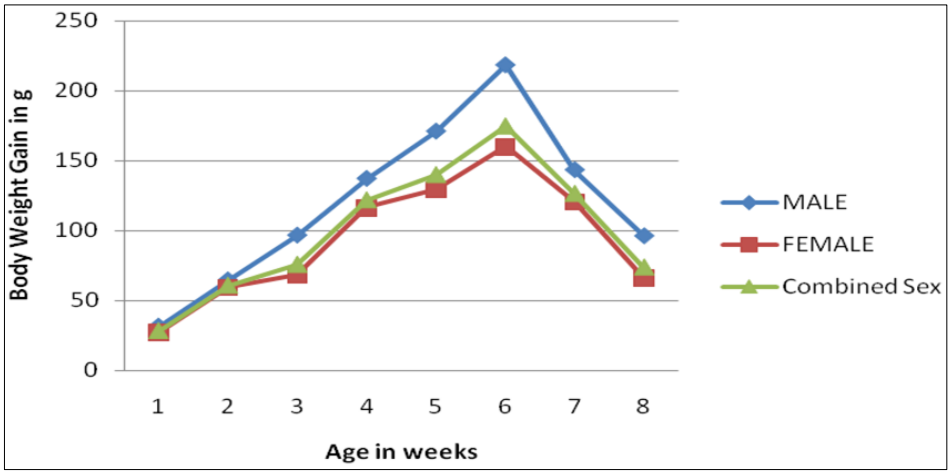

Fig 2: Mean weekly body weight gains of Native *Nusuri* X Broiler cross chicks

Feed and nutrient utilization efficiency

The weekly and cumulative Feed Conversion Ratio (FCR) and Feed Conversion Efficiency (FCE) of Native *Nusuri* × Broiler cross chicks from (0-8) weeks of are is presented in Table 3 and depicted graphically in Figure 1.The 5thweek FCR of cross under study was recorded as 1.92 ± 0.03. The 5th week FCR as reported by Ekka *et al.* (2016) [7] for Hansli × CSML cross was 2.05 which was higher to the FCR obtained in the present investigation. The 5th week FCR value obtained in the present experiment was lower than that of PB2 × Indigenous (2.72), Dahlem red × Native (2.75) and Kamrupa (2.81) which indicates better feed conversion efficiency of the cross under study as compared to the broiler, layer and indigenous and their crosses.

Table 2: Weekly and cumulative FCR and FCE of Native *Nusuri* X Broiler cross chicks

Age (Week)	Weekly FCR	Cumulative FCR	Weekly FCE	Cumulative FCE
1	1.43±0.02	1.43±0.02	0.70±0.003	0.70±0.003
2	1.49±0.04	1.47±0.02	0.67±0.004	0.68±0.004
3	1.72±0.03	1.58±0.02	0.58±0.004	0.63±0.004
4	1.73±0.05	1.65±0.03	0.58±0.004	0.61±0.004
5	1.92±0.03	1.74±0.03	0.52±0.003	0.58±0.003
6	2.00±0.04	1.81±0.04	0.50±0.002	0.55±0.002
7	2.34±0.06	1.91±0.04	0.43±0.003	0.52±0.003
8	2.51±0.13	1.96±0.06	0.40±0.006	0.51±0.006

The 8th week FCR of Native *Nusuri* X Broiler crosses was found to be 2.51± 0.13, which was lower than that of Vanaraja (3.77) as reported by Debata *et al.* (2012) [6]. However lower 8th week FCR value of 2.26 for Hansli × CSML crosses as reported by Ekka *et al.* (2016) [7] who used a broiler sire line and a native population Hansli which are having higher growth potential and better feed conversion efficiency than the broiler dam line and native population used to develop the present cross. Padhi *et al.* (2015) [16] reported 8th week FCR of PD1 × PD4 as 2.79 which was also higher than the 8th week FCR of present cross.

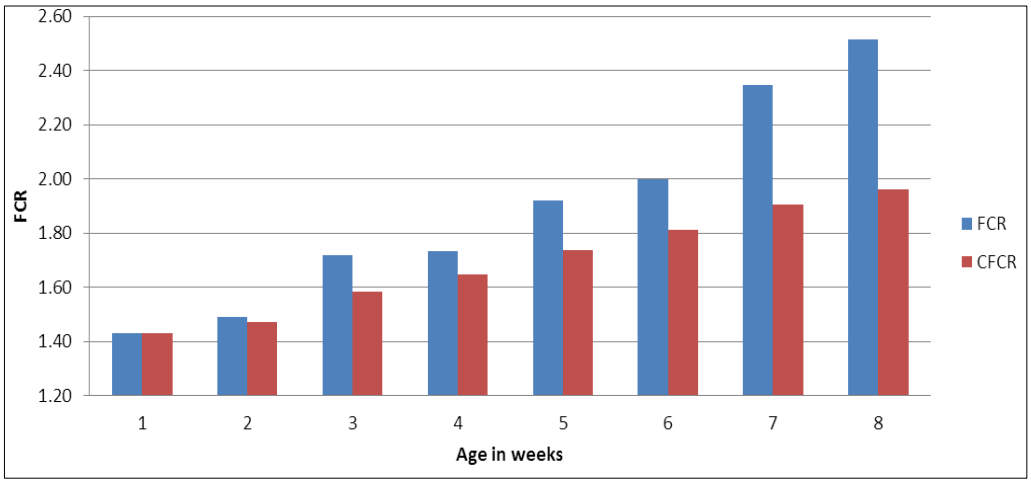

Fig 3: Weekly and cumulative FCR and FCE of Native *Nusuri* × Broiler cross chicks

The ability to convert feed in to body mass is dependent on the genotype and the nutrient content of the feed. Therefore the variability in FCR values as obtained in the present investigation as compared to other crosses could be attributed to those factors.

Protein efficiency ratio (PER) and Protein conversion efficiency (PCE)

The weekly and cumulative Protein efficiency ratio (PER) and protein conversion efficiency (PCE) of Native *Nusuri* X Broiler cross chicks from 0-8 weeks of age are presented in Table 2. On 1st week the PER as well as PCE were 0.14±0.01 and 0.29±0.00 respectively. At the end of 8th week the PER and cumulative PER were 0.08±0.03 and 0.86±0.02 respectively. Similarly the PCE and cumulative PCE were and 0.50±0.03 and 0.39±0.011 respectively for the same period. The weekly PER values showed a declining trend with increase in age where as PCE, it was just the reverse.

Table 3: Weekly and cumulative PER and PCE of Native *Nusuri* × Broiler cross chicks

Age (week)	Weekly PER	Cumulative PER	Weekly PCE	Cumulative PCE
1	0.14±0.01	0.14±0.01	0.29±0.00	0.29±0.004
2	0.13±0.02	0.20±0.01	0.30±0.01	0.29±0.004
3	0.12±0.02	0.25±0.02	0.34±0.01	0.32±0.005
4	0.12±0.02	0.27±0.02	0.35±0.01	0.33±0.006
5	0.10±0.01	0.32±0.01	0.38±0.01	0.35±0.005
6	0.10±0.01	0.34±0.01	0.40±0.01	0.36±0.007
7	0.09±0.01	0.49±0.01	0.47±0.01	0.38±0.008
8	0.08±0.03	0.86±0.02	0.50±0.03	0.39±0.011

Energy efficiency ratio (EER), Energy conversion ratio (ECR)

The weekly and cumulative Energy efficiency ratio (EER), as well as energy conversion ratio (ECR) of Native Nusuri × Broiler cross chicks from 0-8 weeks of age is presented in Table 3. On 1st week the EER as well as ECR were 24.98±0.03 and 0.40±0.001 respectively. At the end of 8th week the cumulative EER and ECR were 18.21±0.11 and 0.55±0.003 respectively. The weekly EER, declined with advancement of age while the ECR values increased.

Table 4: Weekly and cumulative EER and ECR of Native *Nusuri* × Broiler cross chicks

AGE (week)	Weekly EER	Cumulative EER	Weekly ECR	Cumulative ECR
1	24.98±0.03	24.98±0.11	0.40±0.001	0.40±0.002
2	23.48±0.14	24.29±0.02	0.43±0.004	0.41±0.002
3	20.37±0.06	22.55±0.02	0.49±0.002	0.44±0.002
4	20.19±0.08	21.69±0.05	0.50±0.002	0.46±0.003
5	18.20±0.12	20.56±0.06	0.55±0.003	0.49±0.002
6	17.49±0.06	19.70±0.10	0.57±0.001	0.51±0.003
7	14.91±0.13	18.74±0.10	0.67±0.002	0.53±0.004
8	13.90±0.11	18.21±0.11	0.72±0.003	0.55±0.003

Mortality (%)

The mortality of Native *Nusuri* × Broiler cross birds from day-old to 8 weeks of age recorded daily and presented on weekly basis have been presented in Table 4. The mortality during the experimental period of 8 weeks was 10.18 %. Highest mortality was recorded during 8th week of age due to outbreak of infectious coryza. Gonmei (2012) reported mortality ranging 5-10% in indigenous chicken and 5.6% in Vanaraja chicks from 0-5 weeks of age. Khawaja *et al.*(2012) reported mortality of 12, 9 and 7.3% in RIR, Fayaumi and R_1F_1 chicks up to 8 weeks of age. Daida *et al.* (2012) reported that the mortality in CSML × RIR, CSML × B77 and B77 × CSML were 17.06, 9.96 and 12.80 respectively up to 8 weeks of age. From the findings of previous works, it is found that the mortality of experimental birds as recorded in the present investigation were lower than or similar to earlier reported values.

Table 5: Mortality of Native *Nusuri* × Broiler cross chicks

Age (Weeks)	No of birds died
1	1
2	0
3	2
4	0
5	0
6	1
7	1
8	6
Total	11
Mortality up to 0-8 weeks (%)	10.18

Body measurements

The mean linear body measurements of Native *Nusuri* × Broiler crosses at 8th week of age are presented in Table 5. Excluding Shank length and Shank Width, all other linear body measurements parameters were significantly higher in male compared to female. The keel length of males (8.51±0.07cm) was significantly ($p \leq 0.01$) higher than those of females (8.05±0.04cm). The body length of males was 31.22±0.34cm, which is significantly ($p \leq 0.05$) higher than those of female (29.39±0.32cm). The breast angle of males was found to be 39.21±0.42° which was significantly ($p < 0.01$) than those of females with a mean value of 32.50±0.25°.

Table 6: Mean linear body measurements of experimental chicks at 8th week of age

Parameters	Male	Female	T Value	P Value
Shank length (cm)	6.58±0.11	6.21±0.12	2.240	0.060 NS
Shank Width (cm)	1.52±0.01	1.37±0.10	1.520	0.170 NS
Chest Girth (cm)	25.96±0.47	24.55±0.27	3.920	0.008**
Keel length (cm)	8.51±0.07	8.05±0.04	8.790	0.000**
Body length (cm)	31.22±0.34	29.39±0.32	2.620	0.030*
Height (cm)	31.10±0.31	27.63±0.24	5.380	0.002**
Breast Angle (°)	39.21±0.42	32.50±0.25	13.770	0.000**

** Mean values differ significanly ($p \leq 0.01$),* Mean values differ significanly ($p \leq 0.05$) NS- NS- significant

The shank length (male-6.58±0.11cm and female-6.21±0.12cm) and keel length (male-8.51±0.07cm and female-8.05±0.04cm) of experimental chicks were found to be higher than the values reported in native germplasm (shank length: 5.05 cm and keel length: 6.06cm) at 8th week of age maintained by CARI, Izatnagar centre but the breast angle (°) was lower in experimental chicks of Odisha (male-39.21±0.42, female-32.50±0.25) than the values reported in native germplasm maintained by CARI, Izatnagar centre (45.50) at 8th week of age.

Correlations of different body conformation traits with 8 week body weight

The correlation of different body measurement traits with body weight at 8th week of age are presented in the Table 8. The correlation of shank length with breast angle, body length and height were positive and highly significant ($p \leq 0.01$) whereas the correlation of shank length with keel length, shank width and chest girth were positive but non-significant ($p \geq 0.05$). The correlation of chest girth with other body measurement traits were positive but non-significant. The linear body parameters like shank length, breast angle, body length and height are highly correlated with the body weight. Keel length and chest girth are not significantly correlated with the body weight at 8th week of age. The correlation between the body traits like breast angle and keel length is not significant. (r =0.601). The keel length and the shank length are not significantly (R = 0.509) correlated with each other. At 8th week the body weight was positively and significantly ($p \leq 0.01$) correlated with all the body measurement parameters except for chest girth and keel length (Table 8). Ige (2013) [9] reported that 8th week the body weight was positively and significantly ($p \leq 0.01$) correlated with all the body measurement parameters in crosses of Harco Black (HB) and Fulani ecotype chicken (FE). High and positive correlations between linear measurements and body weights in local chickens have been reported by Ibe and Nwakalor, (1987) [8] and in pigeons by Hassan and Adamu, (1997). The correlation of chest girth with other body measurement traits were positive but non significant. The correlation of shank length with breast angle, body length and height were positive and highly significant ($p \leq 0.01$) whereas the correlation of shank length with keel length was positive but non significant ($p \geq 0.05$) which was also in agreement with the findings of Ige, A.O (2013) [9]. Ojedapo (2014) reported that at 8th week of age body weight was non significant with the body length, whereas present study showed a positive and highly correlation between the two traits,

Table 6: Correlations of different body conformation traits with 8th week body weight

	Body weight	Shank length	Keel length	Breast Angle	Shank Width	Chest Girth	Body length	Height
Body weight	1							
Shank length	.964**	1						
Keel length	.605	.509	1					
Breast Angle	.998**	.960**	.601	1				
Shank Width	.762*	.595	.572	.751*	1			
Chest Girth	.344	.418	.431	.347	.086	1		
Body length	.915**	.806**	.683*	.923**	.832**	.148	1	
Height	.954**	.937**	.579	.939**	.735*	.278	.873**	1

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed)

Conclusion

Based on the results obtained from the present study and its subsequent interpretation in light of the available literature, it is well concluded that the Native *Nusuri* × Broiler crossbred chickens has all the potential to become an alternative to commercial broilers as growth performance, linear body measurement are comparable. The correlation between the body weight and body measurements revealed that the correlation of shank length with breast angle, body length and height were positive and highly significant, whereas the correlation of shank length with keel length, shank width and chest girth were positive but non significant. Experimental crossbred chickens could be suitable for small scale rearing in backyard considering the preferential pricing for colored

plumage over commercial broilers. Further, the crossbred chickens being developed using local native germplasm, the birds could thrive and perform better in local climatic conditions in rural small scale farming.

Acknowledgments
The authors are grateful to the All India Coordinated Research Project on Poultry Improvement, Post-Graduate Department of Poultry Science, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha for providing the facilities to carry out this research work.

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