Indian J. Anim. Hlth. (2017), 56(2):211-218

Research Article

PRINCIPAL COMPONENT FACTOR ANALYSIS OF MORPHOSTRUCTURAL TRAITS OF HARINGHATA BLACK CHICKENS

R. SAIKHOM, A. K. SAHOO, S. TARAPHDER*, S. PAN[1], U. SARKAR, P. R. GHOSH[2], D. BHATTACHARYA[3] AND S. BAIDYA[4]

Department of Animal Genetics and Breeding
Faculty of Veterinary and Animal Sciences
West Bengal University of Animal and Fishery Sciences
Kolkata-700 037, West Bengal, India

The study was carried out on Haringhata Black chickens with an aim to investigate the best component for describing the morphological structure using principal component analysis. Statistical analysis showed that mean body measurements were 1.85, 1.47, 4.84, 2.53, 2.98, 1.69, 2.93, 2.46, 3.90, 3.09, 2.45, 1.47, 5.44 and 20.15 cm for ocular length, ocular width, comb length, comb width, earlobe length, earlobe width, wattle length, wattle width, skull length, skull width, beak length, beak width, central toe length and neck length respectively at 24th week of age. Highly significant (P<0.01) positive correlations were obtained ranging from 0.25 (neck length and ocular width; beak width and comb width) to 0.98 (wattle length and wattle width; comb length and comb width). Four principal components were extracted explaining 77.17 % of the total variation in the original variables. First principal component (PC1) had largest share (47.15 %) of the total variance and correlated highly with comb length (0.96), comb width (0.95), wattle length (0.96), wattle width (0.95), earlobe length (0.94) and earlobe width (0.84), while second principal component (PC2) had high positive loadings on ocular width (0.71) and beak length (0.67) at 24th week of age. Therefore, these six variables namely comb length, comb width, wattle length, wattle width, earlobe length and earlobe width have the highest correlations with the PC1 and could be used in characterization of this breed.

Key words: Haringhata Black chicken, Morphostrucrural trait, Principal component analysis

In tropical countries, indigenous chicken breeds have a symbiotic relationship with human communities and play an important role for poultry production in the traditional scavenging system. Haringhata Black chicken plays a pivotal role for sustainable

*Corresponding Author
[1] Department of Livestock Production and Management, WBUAFS
[2] Department of Veterinary Physiology, WBUAFS
[3] Department of Livestock Products Technology, WBUAFS
[4] Department of Veterinary Parasitology, WBUAFS

production system based on traditional practices in rural economy of West Bengal. The future improvement and sustainability of this precious germplasm in its native tract is dependent on the availability of genetic variation. Morphological measurements have been found useful in contrasting size and shape of birds. However, the correlations between body dimensions may differ if the dimensions are treated as bivariates rather than multivariates because of the interrelatedness or lack of orthogonality of the explanatory variables. To overcome this limitation, multivariate analysis of data sets such as the use of principal component factor analysis becomes imperative. In this study, principal components analysis was applied to a set of morpho-structural traits in order to reduce the number of traits for characterization of Haringhata Black chickens.

MATERIALS AND METHODS

Study area: The present research work was performed at Haringhata Poultry Farm, Mohanpur, located in Nadia district of West Bengal and at the Department of Animal Genetics and Breeding, West Bengal University of Animal and Fishery Sciences, Belgachia, Kolkata-700037, West Bengal, India.

Data collection: Data were obtained from 113 selected experimental indigenous Haringhata Black chickens of Haringhata Poultry Farm. The weekly ocular length (cm), ocular width (cm), comb length (cm), comb width (cm), earlobe length (cm), earlobe width (cm), wattle length (cm), wattle width (cm), skull length (cm), skull width (cm), beak length (cm), beak width (cm), central toe length (cm) and neck length (cm) of Haringhata Black chicken were recorded from 2^{nd} week of age to 31^{st} week of age and data obtained at one week interval were eventually used for Principal component analysis (PCA).

The following metric measures were recorded using tape rule (cm): ocular length, ocular width, comb length, comb width, earlobe length, earlobe width, wattle length, wattle width, skull length, skull width, beak length, beak width, central toe length and neck length. Ocular width, comb width, earlobe width, wattle width, skull width and beak width were determined using vernier calliper. The metric measurements were as described by Adeleke *et al.* (2011), Francesch *et al.* (2011), Scott (1982) and Ceballos *et al.* (1989).

Data analysis: Means, standard deviation and coefficients of variation of linear body measurements were calculated using the descriptive statistic of SPSS (Windows version 22, IBM Corp. 2013). Pearson correlation coefficients among the morpho-structural traits were calculated and the correlation matrix was the primary data required for Principal component analysis (PCA). Bartlett's test of sphericity was calculated to test the validity of the factor analysis of the data sets. The suitability of the data set to carry out analysis was further tested using the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy which tested whether the partial correlations among variables were small. A KMO measure of 0.60 and above was considered as adequate (Eyduran *et al.*, 2010). The PCA for morphostructural traits was performed using the factor program of SPSS (Windows version 22, IBM Corp. 2013) statistical package.

RESULTS

The maximum variability of first principal component (PC1) was observed at 24th week of age of Haringhata Black chicken under study. Therefore, the estimate of descriptive statistics, coefficient of correlation and Principal component analysis were presented only for 24th week.

Descriptive statistics: The descriptive statistics for body measurement of morphostuctural traits of experimental indigenous Haringhata Black chickens at 24th week of age were estimated and presented in Table 1. The mean body measurements were 1.85 cm, 1.47 cm, 4.84 cm, 2.53 cm, 2.98 cm, 1.69 cm, 2.93 cm, 2.46 cm, 3.90 cm, 3.09 cm, 2.45 cm, 1.47 cm, 5.44 cm and 20.15 cm for ocular length, ocular width, comb length, comb width, earlobe length, earlobe width, wattle length, wattle width, skull length, skull width, beak length, beak width, central toe length and neck length respectively. Comb width varied more (coefficient of variation = 59.29 %) while Ocular length (coefficient of variation = 3.78 %) varied the least.

Table 1. Mean, standard deviation and coefficient of variation for morpho-structural traits of Haringhata Black chicken at 24th week of age

Parameter	Mean	SD	CV
Ocular length (cm)	1.85	0.07	3.78
Ocular width (cm)	1.47	0.08	5.44
Comb length (cm)	4.84	2.43	50.21
Comb width (cm)	2.53	1.50	59.29
Earlobe length (cm)	2.98	0.93	31.21
Earlobe width (cm)	1.69	0.46	27.22
Wattle length (cm)	2.93	1.38	47.10
Wattle width (cm)	2.46	1.12	45.53
Skull length (cm)	3.90	0.16	4.10
Skull width (cm)	3.09	0.20	6.47
Beak length (cm)	2.45	0.10	4.08
Beak width (cm)	1.47	0.11	7.48
Central toe length (cm)	5.44	0.46	8.46
Neck length (cm)	20.15	1.08	5.36

Coefficient of correlation: The coefficient of correlation of body measurements of indigenous Haringhata Black chicken at 24th week of age were estimated and presented in Table 2. The result of present finding showed positive correlation among all the traits out of which highly significant (P<0.01) correlations (r) were observed ranging from 0.25 (neck length and ocular width; beak width and comb width) to 0.98 (wattle length and wattle width; comb length and comb width) while significant (P<0.05) relationships ranged from 0.19 (beak width and comb length; beak width and wattle width; neck length and skull width) to 0.24 (beak width and ocular width; central toe length and skull width).

Table 2. Correlation coefficients between body measurements of characteristic traits of Haringhata Black chicken at 24th week of age

Traits	Ocular length	Ocular width	Comb length	Comb width	Earlobe length	Earlobe width	Wattle length	Wattle width	Skull length	Skull width	Beak length	Beak width	Central toe length
Ocular with	0.50**												
Comb length	0.07	0.19											
Comb width	0.07	0.20*	0.98**										
Earlobe length	0.08	0.17	0.91**	0.88**									
Earlobe width	0.07	0.15	0.80**	0.76**	0.83**								
Wattle length	0.09	0.18	0.95**	0.94**	0.91**	0.79**							
Wattle width	0.03	0.15	0.94**	0.92**	0.91**	0.81**	0.98**						
Skull length	0.15	0.06	-0.01	0.04	-0.01	-0.05	0.04	0.01					
Skull width	0.14	0.30**	0.53**	0.54**	0.48**	0.38**	0.53**	0.50**	0.30**				
Beak length	0.16	0.38**	0.09	0.14	0.10	-0.01	0.07	0.07	0.02	0.14			
Beak width	0.03	0.24*	0.19*	0.25**	0.23*	0.15	0.20*	0.19*	0.03	0.04	0.41**		
Central Toe length	0.23*	0.21*	0.53**	0.52**	0.53**	0.52**	0.52**	0.55**	0.16	0.24*	0.30**	0.26**	
Neck length	0.10	0.25**	0.52**	0.52**	0.55**	0.43**	0.54**	0.54**	0.22*	0.19*	0.12	0.33**	0.41**

****Correlation coefficients were significant (p<0.01)**
***Correlation coefficients were significant (p<0.05)**

Table 3. Eigen values and percentage of total variance along with the rotated component matrix and communalities for morphostructural traits of Haringhata Black chicken at 24th week of age

Traits	PC1	PC2	PC3	PC4	Communalities
Comb length	0.96	-0.17	0.00	-0.07	0.95
Comb width	0.95	-0.11	-0.02	-0.02	0.92
Wattle length	0.96	-0.16	0.03	-0.04	0.95
Wattle width	0.95	-0.20	-0.02	-0.03	0.95
Earlobe length	0.94	-0.15	-0.04	-0.04	0.90
Earlobe width	0.84	-0.21	-0.02	-0.12	0.77
Ocular length	0.16	0.61	0.39	-0.41	0.72
Ocular width	0.30	0.71	0.12	-0.36	0.74
Beak length	0.19	0.67	-0.39	0.02	0.64
Beak width	0.30	0.45	-0.60	0.31	0.74
Neck length	0.63	0.17	-0.08	0.35	0.55
Skull length	0.09	0.31	0.58	0.70	0.93
Skull width	0.57	0.12	0.47	0.04	0.57
Central toe length	0.64	0.25	-0.08	0.10	0.49
Eigen values	6.60	1.90	1.26	1.05	
% of the variance	47.15	13.54	8.98	7.50	
Cumulative % of the variance	49.15	60.69	69.67	77.17	

PC1 - 1st principal component, PC2-2nd principal comonent, PC3 - 3rd principal component, PC4 - 4th principal component

Communalities, Eigen values of total variance and rotated component matrix: Communalities, Eigen value of the total variance and rotated component matrix of body measurements at 24th week of age of Haringhata Black chicken under this present investigation were estimated and presented in Table 3. The communalities which represent the proportion of the variance in the original variables that is accounted for by the factor solution ranged from 0.49 (central toe length) to 0.95 (comb length, wattle length and wattle width) at 24th week of age of the Haringhata Black chicken in the present study. The Eigen value showed the amount of variance explained by each of the factors out of the total variance. Four common factors were identified with Eigen values of 6.60 (PC1), 1.90 (PC2), 1.26 (PC3) and 1.05 (PC4). The four factors combined accounted for 77.17 % of the total variability present in the parameters measured. The first principal component had the largest share (47.15 %) of the total variance and correlated highly with comb length (0.96), comb width (0.95), wattle length (0.96), wattle width (0.95), earlobe length (0.94) and earlobe width (0.84) at 24th week of age, while PC2 had high positive loadings on ocular width (0.71) and beak length (0.67) and explained only 13.54% of total variance at 24th week of age. Therefore, all these six variables namely comb length, comb width, wattle length, wattle width, earlobe length and earlobe width out of the total fourteen characteristic traits at 24th week of age have the highest correlations with the PC1 and could be used instead of the original interdependent linear type traits in characterization of Haringhata Black Chicken. In this present investigation Kaiser-Meyer Olkin (KMO) measure of sampling adequacy was 0.84 while results of the Bartlett test of sphericity was significant (chi-square 1517.31; P = 0.000) at 24th week of age.

DISCUSSION

Positive and significant (P<0.01/0.05) correlations among the characteristic traits observed in the Haringhata Black chicken of this present investigation indicated high predictability among the variables and may be useful for selection criterion. The results obtained from principal component analysis in the present investigation inferred that comb length, comb width, wattle length, wattle width, earlobe length and earlobe width were highly correlated with first principal component (PC1) which had the largest share while only two traits namely ocular width and beak length had high loading factor for PC2 which explained comparatively less variability out of the total variance of characteristic traits of experimental Haringhata Black chicken. This research finding for Principal Component Analysis in the present study revealed that first principal component had the largest share (47.15 %) of the total variance with higher loading factors of comb length (0.96), comb width (0.95), wattle length (0.96), wattle width (0.95), earlobe length (0.94) and earlobe width (0.84) at 24th week of age, which can be compared with the earlier reports available in the literature. It was reported that the first principal component accounted for the largest variance in the morphological traits of three Nigerian chicken genotypes (Yakubu *et al.*, 2009). Mendes (2011) found that PC1 had the highest correlation with shank length, breast circumference and body weight of Ross 308 broilers. Udeh and Ogbu (2011) reported high loadings of PC1 on breast width (0.930), wing length (0.897) and thigh length (0.789) in Arbor Acre broiler, shank length (0.885) and wing length (0.776) in Marshal broiler, breast width (0.913) and body length (-0.878) in Ross broiler. Ogah *et al.* (2009) reported data that showed PC1 accounting for the largest variance in the body measurements of Muscovy ducks with high positive loadings on body width, bill width, shank length, body length, head length and neck length. Pinto *et al.* (2006) carried out PCA to analyze performance and carcass traits measured in a population of *Gallus gallus*. It was reported that the five first principal components explained 93.30% of the total variation and the first component explained 66.00% (largest share of the total variance). These findings of highest variability of PC1 out of the total variance were in agreement with the results obtained in the present study. Ibe (1989) used PCA in commercial broilers to analyze body weight of birds together with four body measurements namely shank length, keel length, breast width and thigh width at different ages, and reported that the principal components could be used in selection index to simplify them, since such an index would have few principal components instead of all of the original traits.

The significance of principal component analysis as a multivariate statistical tool in the present investigation was evidenced in the reduction of fourteen numbers of explanatory variables into eight components that may be used for characterization of Haringhata Black chicken in future.

ACKNOWLEDGEMENT

The financial support of this research work was funded by the Department of Science and Technology under the Ministry of Science and Technology, Government of India, by awarding Dr. Reshma Saikhom the Inspire Fellowship during Ph.D. degree programme, without which this work could have not been completed.

REFERENCES

Adeleke MA, Peters SO, Ozoje MO, Ikeobi CO and Bamgbose AM *et al*., 2011. Genetic parameter estimate for body weight and linear body measurements in pure and crossbred progenies of Nigerian indigenous chickens. Livest Res Rural Dev, 23(1): http://www.lrrd.Org/lrrd23/ 1 /adel 23019.htm

Ceballos P, Molina J, Franco A and Palacios B, 1989. Manual del Anillador. (ICONA – MAPA), (Madrid): 94–113

Eyduran E, Topal M and Sonmez AY, 2010. Use of factor scores in multiple regression analysis for estimation of body weight by several body measurements in brown trouts (Salmo trutta fario). Int J Agric Biol, 12: 611-615

Francesch A, Villalba I and Cartana M, 2011. Methodology for morphological characterization of chicken and its application to compare Penedesenca and Empordanesa breeds. Anim Genet Resour, 48: 79–84

Ibe SN, 1989. Measure of size and conformation in commercial broilers. J Anim Breed Genet, 106: 461-469

IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp

Mendes M, 2011. Multivariate multiple

regression analysis based on principal component scores to study relationship between some pre- and post- slaughter traits of broilers. J Agricult Sci (Tarim Bilimleri Dergisi.), 17: 77-83

Ogah DM, Alaga, AA and Momoh MO, 2009. Principal component factor analysis of the morph structural traits of Muscovy duck. Int J Poult Sci, 8 (11): 1100-1103

Pinto LFB, Packer IU, De Melo CMR, Ledur MC and Coutinho LL, 2006. Principal components analysis applied to performance and carcass traits in the chicken. Anim Res, 55: 419-425

Scott B, 1982. Clave del observador de aves. In S.A. Omega, ed., Barcelona: 13

Udeh I and Ogbu CC, 2011. Principal component analysis of body measurements in three strains of broiler chicken. Sci World J, 6 (2): 11-14

Yakubu A, Kuje D and Okpeku M, 2009. Principal components as measure of size and shape in Nigerian indigenous chickens. Thai J Agric Sci, 42 (3): 167-176

Article received on15.05.2017 and accepted for publication on 01.09.2017