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Research Article

PRINCIPAL COMPONENT ANALYSIS OF MORPHOLOGICAL TRAITS OF HARINGHATA BLACK CHICKENS IN AN ORGANIZED FARM

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ABSTRACT: The present study was conducted to explore the relationship among body measurement in Haringhata Black Chicken using principal component analysis keeping in view of identifying those components that define body conformation in this breed. The parameters body weight, breast girth, keel length, body length, ornithological measurement, beak length, beak width and back length were recorded and evaluated on 22nd week of age of 113 Chicken. The data showed that the mean body weight was 963 gm and the body measurements were 23.96 cm, 9.80 cm, 59.27 cm, 51.14 cm, 2.38 cm, 1.40 cm and 9.79 cm for breast girth, keel length, body length, ornithological measurement, beak length, beak width and back length at 22nd week of age, respectively. The highest correlation was obtained between body weight and body length (r = 0.86), body length and ornithological measurement (r = 0.86) while correlation between beak width and ornithological measurement (r = 0.26) was observed to be the lowest. Extracted two principal components PC 1 and PC 2 explained 75.70 % of the total variation in the original variables. The first principal component (PC 1) had the largest share (60.02 %) of the total variance and had high positive loadings on body weight (0.93), body length (0.89), ornithological measurement (0.88), breast girth (0.86) and keel length (0.85) while PC 2 shared only 15.68% of the total variance with high positive loadings on beak width (0.75) and beak length (0.68). Therefore, PC1 may be used as selection criteria for improving body weight of indigenous Haringhata Black chicken.

Key words: Haringhata Black chicken, Morphological traits, Principal component analysis.

INTRODUCTION

Rural backyard poultry production plays a vital role in the rapidly growing economy of the country. It contributes in multiple ways to the livelihood and food security of the rural family. Haringhata Black Chicken is one of the most precious poultry germplasm in West Bengal, India. Its main breeding tract is Haringhata Block of Nadia District, West Bengal. Sparse population of the breed is also found in adjoining blocks, *viz.*, Chakdaha block in Nadia district; and Gaighata, Amdanga, Habra-II and Bongaon in North 24 Pargana district. Although existence of Haringhata Black Chicken was reported as early as 1984 (Archarya *et al*. 1984) but little information is available in literature except that it is found chiefly in West Bengal and is black in colour, small bodied with the typical conformation of a layer, but a poor one. It is important to have knowledge of the morphometric traits in Haringhata Black Chicken which could be used as basis for selection and improvement programmes. Principal Component Analysis transforms a number of possibly correlated variables into a smaller number of uncorrelated variables that explain the maximum variability. Therefore, attempt was made to examine the relationship among body measurements in the Haringhata Black chickens with a view of identifying those components that define body conformation of this Chicken breed using multivariate approach of Principal Component Analysis.

MATERIALS AND METHODS

Study area

The present research work was carried out at Haringhata Poultry Farm, Mohanpur, located in Nadia district of West Bengal, India and at the Department of Animal Genetics and Breeding, West Bengal University

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Data collection

Data were collected from 113 experimental indigenous Haringhata Black Chickens of Haringhata Poultry Farm. The weekly body weight (gm), breast girth (cm), keel length (cm), body length (cm), ornithological measurement (cm), beak length (cm), beak width (cm) and back length (cm) were recorded from 2nd week of age to 31st week of age and data obtained at one week interval were eventually used for Principal Component Analysis (PCA).

Body weight of individual birds was measured at weekly interval from 2nd week of age up to the laying stage using electronic weighing balance to the nearest of 0.001 gm accuracy. The following metric measures were recorded using tape rule (cm): breast girth (cm), keel length (cm), body length (cm), ornithological measurement (cm), beak length (cm) and back length (cm). Beak width was determined using vernier calliper. The metric measurements were as described by Ceballos *et al*. (1989), Francesch *et al.* (2011), Adeleke *et al.* (2011).The reference points were: breast girth (the circumference of the breast around its deepest region), keel length (measurement of the length of the sternum, body length (distance from the tip of the beak, through the body trunk to the tail), ornithological measurement (distance from the tip of the beak to the end of the tail when the bird was laid down on its back), beak length (length from the tip of the beak until insertion of the beak into the skull), beak width (measured from the insertion of the beak in the skull and perpendicular until the end of the inferior mandible) and back length (length from insertion of the neck into the body to the saddle).

Data analysis

Means, standard deviation and coefficients of variation of body weight and linear body measurements were calculated using the descriptive statistic of SPSS 22 (2013). The data was pooled for both the sexes. Pearson correlation coefficients among the body measurements of production traits were calculated and the correlation matrix was the primary data required for Principal Component Analysis (PCA). Bartlett's test of sphericity was used to test if the correlation matrix obtained was an identity matrix i.e. each variable correlated to itself or a correlation matrix full of zeros. The data set was further tested for their suitability to carry out Principal Component Analysis (PCA) by 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).

Principal Component Analysis according to Everitt *et al.* (2001), is a method of transforming variables in a multivariate data set, $x_1, x_2, \ldots x_p$ into new uncorrelated variables $y_1, y_2, \ldots y_p$ which account for decreasing proportions of the total variance in the original variables and can be expressed in the form of equations as follows:

$$y_1=a_{11}x_1+a_{12}x_2+ \ldots + a_{1p}x_p.$$
$$y_2=a_{21}x_1+a_{22}x_2+\ldots+ a_{2p}x_p.$$
$$y_p=a_{p1}x_1+a_{p2}x_2+\ldots + a_{pp}x_p.$$

In the above equations, the principal components, $y_1, y_2, \ldots, y_p$ account for decreasing proportions of the total variance in the original variables, viz. $x_1, x_2, \ldots, x_p$. To make the interpretation of the extracted principal components easier, variance maximizing orthogonal rotation was used in the linear transformation of the factor pattern matrix. The Principal Component Analysis (PCA) for production traits was performed by using the factor program of SPSS (Windows version 22, IBM Corp. 2013) statistical package.

RESULTS AND DISCUSSION

Descriptive Statistics

The descriptive statistics for body weight and body measurement traits of indigenous Haringhata Black chickens at 22nd week of age is shown in Table 1 as maximum variability of PC1 was observed in this week. The research finding revealed that the mean body weight was 963 gm while the body measurements were 23.96 cm, 9.80 cm, 59.27 cm, 51.14 cm, 2.38 cm, 1.40 cm and 9.79 cm for breast girth, keel length, body length, ornithological measurement, beak length, beak width and back length, respectively. Statistical analysis of data showed that body weight varied more (coefficient of variation = 22.73 %) while back length (coefficient of variation = 4.80 % in each) varied the least in the studied population.

Coefficient of Correlation

The estimated coefficient of correlation among the body measurement traits of indigenous Haringhata Black chicken at 22 nd week of age is presented in Table 2. The statistical analysis revealed that the coefficient of correlation ranged from r = 0.26 to r = 0.86. The relationships between body weight and all the body measurements were positive and highly significant ($p<0.01$). The highest correlation was obtained between body weight and body length (r = 0.86), body length and ornithological measurement (r = 0.86) while correlation between beak width and ornithological measurement (r = 0.26) was observed to be the lowest.

Table 1. Mean, Standard Deviation and Coefficient of Variation for live body weight and body measurements of Haringhata Black Chicken at 22nd week of age.

Parameter	Mean	SD	CV (%)
Body weight (gm)	963	218.89	22.73
Breast girth (cm)	23.96	2.02	8.43
Keel length (cm)	9.80	0.97	9.90
Body length (cm)	59.27	4.02	6.78
Ornithological measurement (cm)	51.14	4.14	8.10
Beak length (cm)	2.38	0.13	5.46
Beak width (cm)	1.40	0.09	6.43
Back length (cm)	9.79	0.47	4.80

Eigen Values, Percentage of total variance with Rotated component matrix and Communalities

The Eigen value, Percentage of the total variance with rotated component matrix and communalities of body weight and body measurements at 22nd week of age are presented in Table 3. The Eigen value showed the amount of variance explained by each of the factors out of the total variance. Two common factors were identified with Eigen values of 4.80 (PC1) and 1.26 (PC2). The two factors combined accounted for 75.70 % of the total variability present in the parameters measured. PC1 explained 60.02 percent of the total variance while PC2 explained only 15.68 percent. PC1 had high loadings on body weight (0.93), body length (0.89), ornithological measurement (0.88), breast girth (0.86) and keel length (0.85) at 22nd week of age while PC2 being orthogonal to PC1, loaded heavily on beak width (0.75), beak length (0.68) and negative loading was observed for body weight (-0.21), body length (-0.21), ornithological measurement (-0.26), breast girth (-0.19) and keel length (-0.11). The estimated communalities ranged from 0.41 (Back Length) to 0.90 (body weight). Kaiser-Meyer Olkin (KMO) measure of sampling adequacy was 0.86 while results of the Bartlett test of sphericity was significant (Chi-square 648.99; p = 0.000) at 22nd week of age.

The results obtained from Principal Component Analysis of morphological traits of Haringhata Black Chicken studied in the present investigation inferred that PC1 had the largest share of the total variance and correlated highly with body weight, body length, ornithological measurement, breast girth and keel length while PC2 had high positive loadings on beak width and beak length, and negative loadings on body weight, body length, ornithological measurement, breast girth and keel length at 22nd week of age. In PC2 for production traits, this implied that an increase in beak width and beak length results to correlated decrease in body weight, body length, ornithological measurement, breast girth and keel length of Haringhata Black Chicken.

This research finding for Principal Component Analysis can be compared with the earlier reports available in the literature. In Principal Component Analysis of body measurements of broilers, Yakubu *et al.* (2009 a,b) also reported that PC1 had high positive loadings on body weight, breast circumference and thigh length of Arbor Acre broiler and they also reported that first principal component accounted for the largest variance in the morphological traits of three Nigerian chicken genotypes. This report was in accordance with the present finding of Haringhata Black Chicken. Mendes (2011) reported that PC1 had the highest correlation with

Table 2. Correlation coefficient among the morphological traits of Haringhata Black Chicken at 22nd week of age.

Trait	Body Weight	Breast Girth	Keel Length	Body Length	Ornitho logical Measurement	Beak Length	Beak Width
Breast Girth	0.84**						
Keel Length	0.77**	0.73**					
Body Length	0.86**	0.71**	0.69**				
Ornithological Measurement	0.84**	0.71**	0.70**	0.86**			
Beak Length	0.37**	0.35**	0.44**	0.39**	0.34**		
Beak Width	0.33**	0.28**	0.29**	0.28**	0.26**	0.61**	
Back Length	0.46**	0.45**	0.44**	0.44**	0.44**	0.39**	0.30**

**(p<0.05)

Table 3. Eigen Values and Percentage of Total Variance along with the Rotated Component Matrix and Communalities for morphological traits of Haringhata Black breed of chicken at 22nd week of age.

Traits	PC1	PC2	Communalities
Body Weight	0.93	-0.21	0.90
Body Length	0.89	-0.21	0.83
Ornithological Measurement	0.88	-0.26	0.83
Breast Girth	0.86	-0.19	0.77
Keel Length	0.85	-0.11	0.73
Back Length	0.61	0.19	0.41
Beak Width	0.48	0.75	0.78
Beak Length	0.58	0.68	0.79
Eigen Values	4.80	1.26	——
% of the Variance	60.02	15.68	——
Cumulative % of the Variance	60.02	75.70	——

shank length, breast circumference and body weight of Ross 308 broilers. Udeh *et al*. (2011) reported that PC1 had high loadings 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 ducks with high positive loadings on body width, bill width, shank length, body length, head length and neck length. Pinto *et al.* (2006) performed PCA to analyze performance and carcass traits measured in a population of *Gallus gallus* and reported that the five first principal components explained 93.30% of the total variation out of which the first component explained 66.00% (largest share of the total variance) which was in close conformity with the present finding. The high positive loading on body length in the present study was also at bar with the findings of Ogah *et al.* (2009) and Egena *et al.* (2014) who also obtained a high loading of 0.766 and 0.814 on body length respectively. The result of the present study was also in close conformity with those of Egena *et al.* (2014) and Udeh *et al*. (2011) who reported high positive loadings of PC1 on body weight (0.826) and breast width (0.930 in Arbor Acre Broiler and 0.913 in Ross Broiler) respectively. Ibe (1989) used PCA in commercial broilers to analyze body weight of birds at different ages, together with four body measurements namely shank length, keel length, breast width and thigh width 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.

CONCLUSION

The Principal component analysis explored the interdependence in the original eight morphometric traits out of which only five traits namely body weight, breast girth, keel length, body length, ornithological measurement, beak length, beak width and back length had the highest loading factors for first principal component (PC1) which explained the maximum variability of size and shape of this breed of Haringhata Black chickens at 22nd week of age. These could be used instead of the original interdependent linear type traits in estimating the body weight of Haringhata Black Chicken. Therefore, first principal component (PC1) may be considered in selection, characterization and conservation of Haringhata Black Chicken for further improvement.

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