Nigerian J. Anim. Sci. 2019, 21 (2): 30-38

Description of body conformation of Nigerian Indigenous Turkeys using exploratory factor analysis

Durosaro, S.O.*, Ilori, B.M., Ajani, A.O. and Ozoje, M.O.

Department of Animal Breeding and Genetics, Federal University of Agriculture, Abeokuta

***Corresponding Author:** durosaroso@funaab.edu.ng

***Target Audience**:* Poultry Breeders, Geneticists, Morphologists and Biometricians

Abstract

Body dimensions are used to characterise livestock species. Factor analysis is a multivariate technique for examining the interrelationship among a set of variables that are correlated. Factor analysis was used to describe body conformation of Nigerian indigenous turkeys in this study. The biometric traits of Nigerian indigenous turkeys were measured at 20th week of age and subjected to PROC FACTOR of SAS using varimax criterion of orthogonal rotation method. The highest Pearson correlation coefficient of 0.94 was observed between wing length and wing span. Three factors accounted for 87.41% of the total variance. The first factor accounted for 50.23% of the total variance, the second factor accounted for 24.39% while the third factor accounted for 12.79% of the total variance. The communality ranged from 0.77 in body weight to 0.98 in breast girth. All the biometric traits studied were very effective in explaining body conformation in Nigerian indigenous turkeys. Three factors explained all the biometric traits of Nigerian indigenous turkeys. The first factor explained body weight, body length, shank length, thigh length and keel length. The second factor explained wing parts while the third factor explained only the breast girth. It can therefore be concluded that the three factors obtained in this study described body conformation of Nigerian indigenous turkeys.

***Keywords**:* Turkey; Body dimension; Communality; Unique factor

Description of Problems

Biometric traits are used to characterise poultry species. They are also used to indicate origin, shape and size of animal genetic resources as they give idea of body conformation (1). Body measurements and indices estimated from different body traits are used as indicator of type and function in domestic animals (2).

Body structure of different livestock species have been analysed using different methods. (3) used principal component to analyse body measurements in a population of indigenous Nigerian chickens raised under extensive management system. (4) used multideterminant approach to analyse body structure in Djallonke sheep. (5), (6) and (7) used factor analysis to study body measurements in cattle. (8) used varimax-rotated principal component factor analysis to analyse zoometrical traits in Uda sheep while (9) used principal component analysis to study body conformation traits in Yankassa sheep.

Factor analysis is a multivariate technique for examining the interrelationships among a set of variables that are correlated. It is a variable reduction technique which identifies the number of latent constructs and the underlying factor structure of a set of variable. It hypothesizes an underlying construct, a variable not measured directly. It includes unique factor and error due to unreliability in measurement (10). It is used traditionally to explore the possible underlying factor structure of a set of measured variables without imposing any preconceived structure on the outcome (11). It is different from principal component analysis in that its factors account for common variance in the data while principal components retained account for a maximal amount of variance in observed variables. The observed variables in factor analysis are linear combinations of the underlying and unique factors while component scores in principal component analysis are a linear combination of the observed variables weighted by eigenvectors (10).

Nigerian indigenous turkeys are reared as natural scavengers and foragers. They are rugged and adapted to tropical climate. These birds are functionally and genetically valuable because they contain genetic materials which may have been lost in exotic turkey breeds (12). They are mainly raised for meat and are of three colour variants which are white, black and lavender.

The objectives of this study were to determine the relationship among biometric traits and identify factors that define the body conformation in Nigerian indigenous turkeys.

Materials and Methods

Experimental site

The experiment was carried out at the Turkey Breeding Unit of the Teaching and Research Farm of the Department of Animal Breeding and Genetics, Federal University of Agriculture, Abeokuta, Alabata, Ogun State Nigeria. Alabata (latitude $7^{0}10'$N and longitude $3^{0}2'$E) is in Odeda Local Government Area of Ogun State, Nigeria. The area which lies in the South Western part of Nigeria has a prevailing tropical climate with a mean annual rainfall of about 1037 mm. The mean ambient temperature ranges from 28^{o}C in December to 36^{o}C in February with a yearly average humidity of about 82% (12). The vegetation represents an interphase between the tropical rainforest and the derived savannah.

Source, sample size and management of experimental birds

The experimental birds were generated from mating of pure indigenous parent stocks (24 sires and 52 dams) available on the farm through artificial insemination as described by (12). Three hundred and eight (308) progenies were raised for 20 weeks and used for the experiment. The experimental birds were raised under intensive management system. The poults were brooded in deep litter pens at the brooding stage. All progenies were wing-tagged along the sire-dam line that has been formerly marked for proper identification and subjected to the same management practices throughout the experimental period. Recommended feeds (13, 14) for turkeys were provided at two phases (starter and grower) of the experiment. Clean water was also provided for the birds *ad libitum*. Vaccination schedule for turkey was strictly adhered to and adequate sanitation was practised to prevent occurrence of diseases.

Data collection

The biometric traits of Nigerian indigenous turkeys at 20^{th} week of age were measured as described below:

Body weight: This was recorded by placing individual bird on Avery Berkel scale with a capacity of 25kg.

Body length: This was measured as the distance between the base of the snood and the base of the cloaca using measuring tape.

Shank length: This was measured as the distance between the tarsometatarsus and the hock joint.
Keel length: This was measured as the length of the cartilaginous keel bone or metasternum.
Wing length: This was measured as the length from the shoulder joint to the extreme of the terminal balance.
Thigh length: This was measured as the distance between the hock joint and pelvic joint.
Breast girth: This was measured as the circumference of the breast around the deepest region.
Wing span: This was measured as the distance between the left wing tip to the right wing tip across the back of the turkey.

Statistical analyses

The biometric traits were analysed using PROC FACTOR of SAS (15). The varimax criterion of the orthogonal rotation method was employed for the rotation of factor matrix. The choice of varimax rotation was informed by its ability to maximize sum of the variances of the squared loadings within each column of the loading matrix. This tends to produce some higher loadings and some loadings near zero which is one of the aspects of the simple structure that enhance the interpretability of the factors.

The Kaiser rule criterion (16) was used to determine the number of factor, retaining only the factors that have eigenvalue greater than 1. Kaiser's measure of sampling adequacy was used to determine whether the common factor model was appropriate. A sampling adequacy below 0.5 was not accepted. The common factor model is stated below:

$$Y = X\beta + E$$

Where Y is a matrix of measured variables
X is a matrix of common factors
B is a matrix of weights (factor loading)
E is a matrix of unique factors, error variation

Results and Discussion

Descriptive statistics

The descriptive statistics of the biometric traits of Nigerian indigenous turkeys were shown in Table 1. The standard error for all the biometric traits ranged from 0.06 to 26.19 with body weight having the highest value. Also, the coefficient of variation for different biometric traits ranged from 8.59 in wing length to 55.58 in breast girth. Biometric traits are used to characterise the different breeds of livestock. The mean values of the biometric traits were within the range reported by (13) and (14). The highest coefficient of variation observed in breast girth suggested more variability which may due to the fact that selection has not been applied on the trait or that this part responds more to some underlying environmental factors such as nutrition than the other parts. The lowest coefficient of variation observed in wing length of Nigerian indigenous turkey is in tandem with the report of (3) who also observed the least coefficient of determination in wing length of indigenous Nigerian chickens raised under extensive management system.

Table 1: Descriptive statistics of the biometric traits of Nigerian indigenous turkeys

Trait	Mean	Standard error	Coefficient of variation	Standard deviation
Body weight (g)	2846.25	26.19	17.04	485.26
Body length (cm)	39.26	0.20	9.60	39.26
Shank length (cm)	14.20	0.11	14.32	14.20
Thigh length (cm)	19.28	0.12	11.29	19.20
Keel length (cm)	13.28	0.06	8.62	13.28
Breast girth (cm)	46.90	1.41	55.58	46.90
Wing length (cm)	31.36	0.15	8.59	31.36
Wing span (cm)	66.77	0.31	8.61	66.77

Correlations among the biometric traits

The Pearson correlations among the biometric traits were shown in Table 2. The correlation coefficient ranged from -0.18 (shank length and breast girth) to 0.94 (wing length and wing span). Negative correlation was observed between breast girth and other traits except with body weight, wing length and wing span. Also, very low correlation existed between wing span and other traits except with wing length. Correlations indicate the interrelationships among traits and such knowledge is very useful in breeding, conservation and management of livestock species (4). The positive correlations among some of the biometric traits suggested high predictability among these traits. This is suggestive of prediction of one trait using the correlation value of the other. Highly correlated traits are more likely to be governed by the same gene action indicating that one gene is having an effect on the other and could form the basis for genetic selection and upgrading of indigenous stock (9). Selection for positively or negatively associated traits is influenced by the production objectives, selection goals and socio-cultural demands.

Table 2: Correlation coefficients among the biometric traits of Nigerian indigenous turkeys

	BW	BL	SL	TL	KL	BG	WL	WS
BW		0.77	0.60	0.71	0.81	0.03	-0.02	-0.02
BL			0.77	0.85	0.83	-0.03	0.01	0.01
SL				0.70	0.74	-0.18	-0.02	-0.02
TL					0.73	-0.01	-0.05	-0.06
KL						-0.08	-0.01	-0.01
BG							0.08	0.07
WL								0.94
WS								

BW: body weight, BL: body length, SL: shank length, TL: thigh length, KL: keel length, BG: breast girth, WL: wing length, WS: wing span

Variance explained by each factor

The eigenvalue of each factor and variation explained by each factor were shown in Table 3. The scree plot showing eigenvalue and component number was shown in figure 1. There were three factors extracted with eigenvalues greater than 1. These three factors accounted for 87.41% of the total variance. The first factor accounted for 50.23% of the total variance, the second factor accounted for 24.39% of the total variance while the third factor accounted for 12.79%. Three factors accounted for the total variance in the biometric traits of Nigerian indigenous turkeys. The first factor explained the highest variation. (3), (17), (2) and (5) also reported that the first factor explained the highest variation in chicken, turkey, sheep and cattle, respectively. The significant positive high loading for body weight, body length, shank length, thigh length and keel length by the first factor indicated that the first factor explained all body parts except breast and wing parts. Also, the significant positive high loading for wing length and wing span by the second factor indicated that the second factor explained the wing parts (wing span and wing length) while the significant positive high loading for breast girth by the third factor suggested that the third factor explained only the breast part.

Table 3: Variance explained by the factors

	Initial eigenvalue			Extracted sums of loadings		
Factor	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	4.02	50.23	50.23	4.02	50.23	50.23
2	1.95	24.39	74.62	1.95	24.39	74.62
3	1.02	12.79	87.41	1.02	12.79	87.41
4	0.38	4.73	92.14			
5	0.29	3.60	95.74			
6	0.16	2.03	97.77			
7	0.12	1.48	99.25			
8	0.06	0.75	100.00			

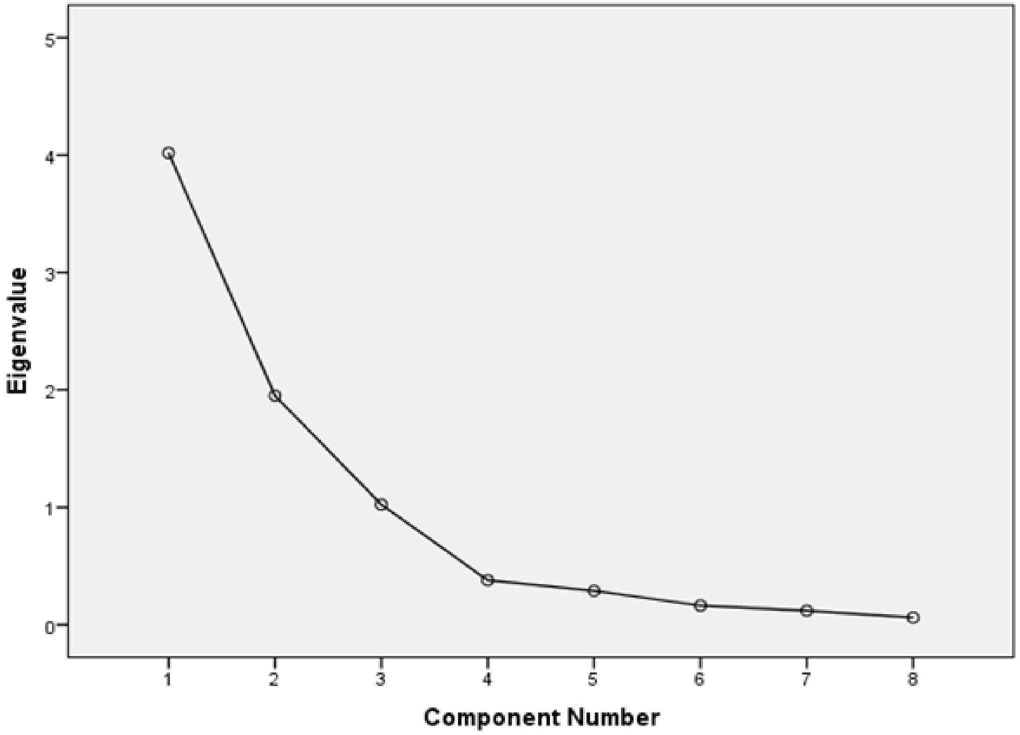

Figure 1: The scree plot showing eigenvalue and component number

Sampling adequacy (KMO), Communality and component matrix of different factors

Communality and unique factor of the eight biometric traits were shown in Table 4. The overall KMO was 0.78. The overall significance of the correlations tested with Bartlett's test of Sphericity was 2332.63 at significance value of 0.000. The communality ranged from 0.77 in body weight to 0.98 in breast girth while the unique factor ranged from 0.02 to 0.24. The component matrix of the three factors was shown in Table 5 and Figure 2.

The first factor gave positive weight to all the traits except breast girth, wing length and wing span while the second factor gave positive weight to all the traits except body weight, shank length and thigh length. The third factor gave positive weight to all the traits except body length, shank length and keel length. The observed high value of KMO in this study indicated that the correlations among the biometric traits were unique. The correlations were not related to the remaining variables outside each correlation (3). The KMO estimate of sampling adequacy showed the proportion of the used traits caused by the underlying factors. A KMO value of less than 0.5 is an indication that the analysis is inappropriate. The significance of the correlation of the correlation matrices tested with Bartlett's test of sphericity for the biometric traits of Nigerian indigenous turkeys provided ample support for the authenticity of using factor analysis for these traits. Although (3) also observed significant Bartlett's test of sphericity for body measurements in chickens, lower estimate of Bartlett's test of sphericity (1478.00) was observed compared to this study. (8) observed significant Bartlett's test of sphericity for zoometrical traits in Uda sheep while (5) also observed overall significance of the correlations tested with Bartlett's test of sphericity for biometric traits in Kankrej cows. Communality, which is the first part, is the common variance that is shared by other variables included in the model. The estimate of communality for each variable measures the proportion of variance of the variables explained by all the other factors jointly. The second factor is called specific variance (unique factor) as it is specific to a particular variable and includes the error variance. The unique factor is the unreliability due to measurement error and variation in the data. The high communalities obtained for all the traits indicated that these traits contributed significantly to total variation in body conformation of the Nigerian indigenous turkeys. High communalities have also been reported in broiler chickens by (18) and Nigerian indigenous turkeys by (17). The highest communality observed in breast girth was in contrary to the findings of (3) which reported lowest communality of breast girth in Nigerian indigenous chickens. Although the communalities obtained in this study were high, the communality of flesh dimension (breast girth) was higher than skeletal dimension (length) and this is contrary to the findings of (17) and (3) who reported different findings in adult Muscovy ducks and Nigerian indigenous chickens.

Factor analysis is used in ranking animals and thus, provides an opportunity to select the animals based on a group of variables rather than an isolated trait (8). It estimates factors underlying constructs that cannot be measured directly (10). It describes objectively the underlying dimension of size and shape. Factor analysis also permits the elimination of redundancies from set of interdependent variables, extract and identify covariant variable sets that are statistically unrelated (8, 19).

Table 4: Communality and unique factor

Trait	Communality	Unique factor
Body weight	0.77	0.23
Body length	0.90	0.10
Shank length	0.76	0.24
Thigh length	0.80	0.20
Keel length	0.85	0.15
Breast girth	0.98	0.02
Wing length	0.97	0.03
Wing span	0.97	0.03

Overall measure of sampling adequacy: 0.78

Table 5: component matrix of different factor

Trait	1	2	3
Body weight	0.87	-0.017	0.105
Body length	0.95	0.015	-0.002
Shank length	0.84	-0.002	-0.219
Thigh length	0.89	-0.049	0.033
Keel length	0.92	0.010	-0.048
Breast girth	-0.03	0.048	0.988
Wing length	-0.01	0.984	0.036
Wing span	-0.01	0.984	0.024

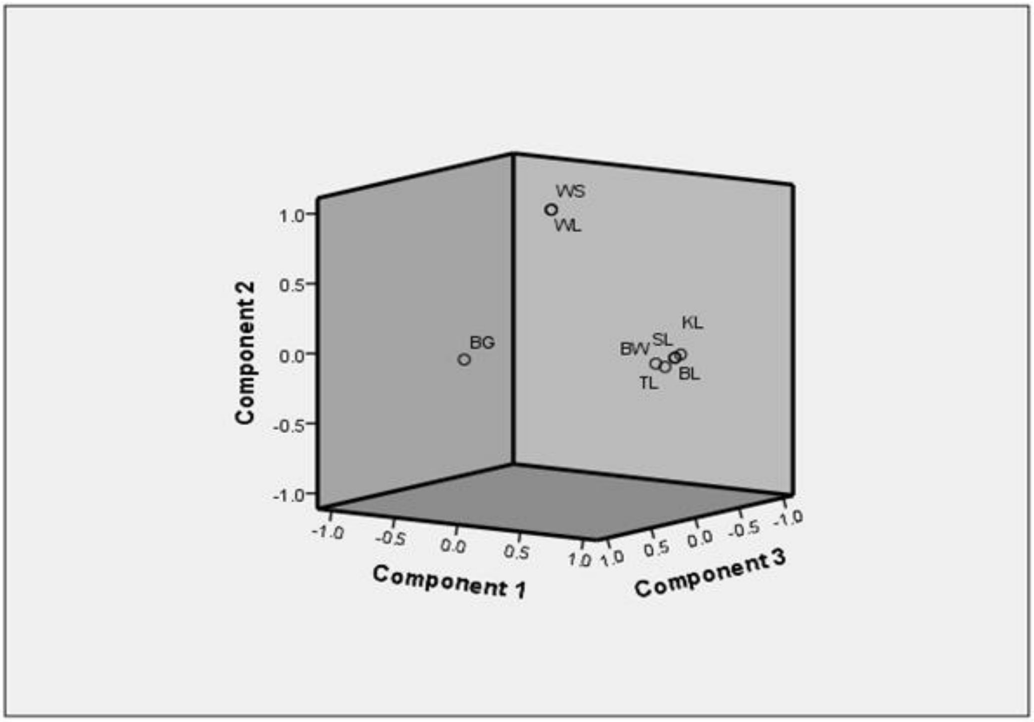

Figure 2: Component plot in rotated space

Conclusions and Applications

1. The biometric traits observed contributed significantly to total variation in body conformation of Nigerian indigenous turkeys.
2. The work described the relationship among biometric traits and body parts as a single factor.
3. The three factors obtained in this study defined body conformation of Nigerian indigenous turkeys and can therefore be used for selection purpose.
4. Factor analysis can be used to characterise Nigerian indigenous turkeys.

References

1. Simon, D.L. and Buchenauer. (1993). Genetic diversity of European livestock breeds, Wageningen.
2. Salako, A.E. (2006). Principal component analysis of the morphostructure of immature Uda sheep. *International Journal of Morphology*, 24(4): 571-574.
3. Egena, S.S.A., Ijaiya, A.T., Ogah, D.M. and Aya, V.E. (2014). Principal component analysis of body measurements in a population of indigenous Nigerian chickens raised under extensive management system. *Slovak Journal Animal Science*, 47(2): 77-82.
4. Birteeb, P.T., Peters, S.O. and Ozoje, M.O. (2014). Analysis of the body structure of Djallonke sheep using a multideterminant approach. *Animal Genetic Resources*, 54: 65-72
5. Pundir R.K., Singh, P.K., Singh, K.P. and Dangi, P.S. (2011). Factor analysis of biometric traits of Kankrej cows to explain body conformation. *Asian-Australasian Journal of Animal Science*, 24(4): 449-456.
6. Tolenkhomba, T.C., Konsam, D.S., Singh, N.S., Prava, M., Singh, Y.D., Ali, M.A. and Motina, E. (2012). Factor analysis of local cows of Manipur, India. *International Multidisciplinary Research Journal*, 2(2):77-82.
7. Pares-Casanova, P.M. and Mwaanga, E.S. (2013). Factor analysis of biometric traits of Tonga cattle for body conformation characterization. *Global Journal of Multidisciplinary and Applied Sciences*, 1(2): 41-46.
8. Yakubu, A., Salako, A.E. and Abdullah, A.R. (2011). Varimax rotated principal component factor analysis of the zoometrical traits of Uda sheep. *Archivos de. Zootecnia*., 60: 813-816.
9. Yakubu, A. (2013). Principal component analysis of the conformation trait of Yankassa sheep. *Biotechnology Applied to Animal Husbandry*, 29: 65-74.
10. Suhr, D.D. (1999). Principal component analysis vs exploratory factor analysis. *Statistics and Data Analysis* (SUGI), 30: 1-11
11. Child, D. (1990). The essentials of factor analysis. 2nd edition, London: Cassel Educational Ltd.
12. Johnson, R.A and Wichern, D.W. (1982). Applied multivariate statistical analysis. Prentice-Hall, Inc., Englewood Cliffs, NJ.
13. Durosaro, S.O., Taiwo, O.T., Sanda, A.J., Wheto, M., Ilori, B.M., Adebambo, A.O. and Ozoje, M.O. (2016). Comparison of non-linear growth models in describing the growth curve of Nigerian indigenous turkeys. *Nigerian Journal of Genetics,* 31: 102-109.
14. Ilori, B.M., Akano, K., Durosaro, S.O., Adebambo, A.O. and Ozoje, M.O.

(2016). Estimates of repeatability for growth traits of pure and crossbred turkeys in the tropics. *Nigerian Journal of Animal Production*, 43(1): 27-36.

15. Adebambo, O.A. (2003). Animal Breeds: A National Heritage. *University of Agriculture, Abeokuta Inaugural Lecture Series*, 16: 47-77.
16. SAS (2002). Statistical analysis system. Users guide. Cary. North Caroline, USA.
17. Ogah, D.M. (2011). Assessing size and conformation of the body of Nigerian indigenous turkey. *Slovak Journal of Animal Science*, 44:21-27.
18. Ajayi, O.O., M.A. Adeleke, M.T. Sanni, A. Yakubu, S.O. Peters, I.G. Imumorin, M.O. Ozoje, C.O.N. Ikeobi, O.A. Adebambo. (2012). Application of principal component and discriminant analyses to morphostructural indices of indigenous and exotic chickens raised under intensive management system.*Tropical Animal Health and Production*, 44 (6):1247-1254
19. Shahin, K.A., Soliman, A.M. and Moukhtar, A.E. (1995). Sources of shared variability for the Egyptian cattle body shape (conformation). *Indian Journal of Animal Science*, 65:759-764.