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ESTIMATION OF BODY WEIGHT FROM LINEAR BODY MEASUREMENTS IN TWO COMMERCIAL MEAT-TYPE CHICKENS RAISED IN SOUTHERN GUINEA ENVIRONMENT OF NIGERIA USING PRINCIPAL COMPONENT ANALYSIS APPROACH

Amao Shola Rasheed*[1]

[1*]Department of Agricultural Education (Animal Science Division, Animal Breeding and Genetics Unit), School of Secondary Education (Vocational and Technical Programmes), Emmanuel Alayande College of Education, P.M.B. 1010, Oyo. Oyo State, Nigeria.

ABSTRACT

The uses of principal components analysis (PCA) were recently common in analysis of relationships between scores of variables in animals. The study adopted the PCA methods in estimation of body weight from linear body measurements in two commercial meat-type chickens raised in southern guinea environment of Nigeria. A total of 300 birds comprise of 150 each of Marshall and Arbor acre broiler chickens were used for the study. Traits measured were body weight (BW), Body length (BDL), keel length (KL), Breast width (BRW), Thigh length (TH), shank length (SHK) and wing length (WG). The descriptive statistics indicated that the average BDW (1.63 vs 1.91kg), BDL (20.63 vs 20.76cm), KL (10.53 vs 10.47cm), BRW (3.24 vs 3.07cm), TH (10.11 vs 10.09), SHK (11.67 vs 11.85cm) and WG (22.30 vs 23.08cm) were obtained for Marshall and Abor acre, respectively. The correlation coefficient observed varied from r = 0.72 to r = 0.96 for Marshall while the ranged of r =0.73 to r = 0.95 was recorded for Abor acre while all variables were positive and highly significant (P<0.01). The PCA results revealed that three principal components were extracted for the broiler chickens explaining 95.28 % and 94.82 % of the total variation in the original variables for both Marshall and Arbor acre chicken. However, Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy values are 0.90 and 0.92 were termed to be marvelous with Bartlett's test of 9026.63 and 8715.13 at determinants 1.37E and 2.39E for Marshall and Arbor acre birds, respectively. These components could be a template for selection criteria for breeding programme in broiler chickens.

KEYWORDS

Principal component analysis, Growth traits, Marshall broiler and Abor acre broiler.

Author for Correspondence:
Amao Shola Rasheed,
Department of Agricultural Education,
Emmanuel Alayande College of Education,
P.M.B.1010, Oyo. Oyo State, Nigeria.
Email: sholaamao@gmail.com

INTRODUCTION

Broiler is a domesticated feathered bird reared mainly for meat production reaches market weight of about 1.5kg -3.0kg between six and ten weeks of age depending on feed quality and quantity, health, environmental factors and their management practices (Abanikannda *et al*, 2010)[1]. According to

Amao *et al*, (2015)[2] live weight and other conformation traits are known to be good indicators of body growth and market value of broiler chicken, such conformation traits were thigh length, breast girth length, neck length, back length and shank length and body weight among others. The body weight of any animal is an important parameter that determines the market value of that animal. The relationship between body weight and other linear body measurements has been described to have an important implication in the production of broilers and these relationships were always direct and positive (Amao *et al*, 2012)[3]. Henry *et al*, (2011)[4] opined that one of the criteria for genetic improvement is the knowledge of genetic parameters for important economic traits while successful breeding programme relies on the ability to established relationship that exists between identified variables or traits.

The principal component analysis is a variable reduction procedure and is appropriate when obtained measures or a number of observed variables and to develop a smaller number of artificial variables. The principal components may be used as predictor or criterion traits in subsequent analysis (Alphonsus *et al*, 2013[5] and Amao, 2018[6]). Therefore, the objective of this study was to explore the relationship between body weight, body length, breast length, keel length, shank length and wing length in two commercial broiler chickens using principal components analysis approach.

MATERIAL AND METHODS

Site of the experiment

The study was conducted at the Poultry Unit of Teaching and Research Farm, Emmanuel Alayande College of Education, Oyo, Oyo State, Nigeria and Oyo lies on the longitude 3° 5' east of the green witch meridian and latitudes 7° 5' North eastwards from Ibadan, the capital of Oyo State. The altitude is between 300 and 600 meter above water level. The mean annual temperature and rainfall are 27°C and 1,165mm respectively. The vegetation of the area is Southern guinea savanna zone of Nigeria (Amao, 2017)[7].

Experimental Animals and Management

A total of 300 day-old chicks comprises of 150 each of Marshall and Abor acre birds were used for the study and were procured from a reputable hatchery in Ibadan. Each of the bird were tagged using wing band according to their strain and placed in environmentally controlled brooder house with floor covered with wood shavings which was kept dry throughout the experiment period by replacing soiled litter when required. All necessary vaccination were administered as at when due.

Feed and feeding of the birds

Birds were fed *ad-libitum* on a broiler starter diet containing 20 % crude protein and 2880 kcal/kg Metabolizable energy from day old to 4th week followed by finisher diet of 16 % crude protein and 2600kcal/kg Metabolizable energy. Clean and cool water was provided *ad-libitum.*

Collection of data

The body weights (BDW) of the birds were obtained on weekly basis to 8 weeks of age. The body measurements includes shank length (SHL), thigh length (TH), body length (BDL), keel length (KL), breast width (BRW) and wing length (WG) were measured from day old to 8 weeks of age on a weekly bases on each of the strain as described by Amao (2018)[6].

Principal component analysis procedures

Principal component analysis is a method for transforming the variables in a multivariable data set X_1, X_2…….. X_n into new variables Y_1, Y_2……Y_n, which are unrelated with each other and account for decreasing proportions of the total variance of the original variables, defined as

$Y1 = P_{11}X_1 + P_{12}X_2 + \ldots\ldots\ldots\ldots + P_{1n}X_n$

$Y2 = P_{21}X_1 + P_{22}X_2 + \ldots\ldots\ldots\ldots + P_{2n}X_n$

$Y3 = P_{n1}X_1 + P_{n2}X_2 + \ldots\ldots\ldots\ldots + P_{nn}X_n$

With the coefficient being chosen so that Y1, Y2 …… Yn account for decreasing proportion of the total variance of the original variables, X1, X2 …….. Xn (Everitt *et al*, (2001)[8]. Eyduran *et al*, (2010)[9] indicated that Bartletts test of sphericity was used to test if the correlation matrix was an identity matrix (each variable correlated with itself) or a correlation matrix full of zero. The suitability of the information set to PCA was further tested by Kaiser-

Meyer-Olkin (KMO) measure of sampling adequacy. This tested whether the partial correlations among variables were small. A KMO measure of 0.60 and above is considered adequate while variance maximizing orthogonal rotation was used in the linear transformation of the factor pattern matrix in order to bring about the interpretation of the extracted principal components easier.

Statistical analysis

Means, standard errors, minimum and maximum of body weight and body measurements of each strain of broilers were obtained using the descriptive statistic of SPSS 22 (2013)[10] while the correlation matrix which was the primary information required for PCA generated. The principal components analyses were done using the factor program of SPSS 22 (2013)[10] statistical package.

RESULTS

The means, standard deviation (SD), minimum, maximum and coefficient of variation for the body weight and linear body measurement of Marshall and Arbor acre broiler chickens are presented in Table No.1. The mean body weight for Arbor acre broiler was 1.91kg while the other linear body measurements were 20.63cm (BDL), 10.52cm (KL), 3.24cm (BRW), 10.13cm (TH), 11.67cm (SHK) and 22.30cm (WG) respectively. The body weight varied more (CV = 63.16 %) while shank length had the least CV of 25.93 %. However, the descriptive statistics for body weight and other linear measurements traits of Marshall broiler chicken; the body weight obtained was 1.63kg, body length, keel length, breast width, thigh length, shank length and wing length were of values 20.76cm, 10.47cm, 3.07cm, 10.07cm, 11.35cm and 23.08cm, respectively. Body weight varied more of value 58.86 % with 29.17 % obtained for shank length as the least coefficient of variation.

The correlation coefficient of body weight and linear body measurements of Marshall and Arbor acre broiler chickens at finisher phase is as shown in Table No.2. The relationship between the body weight and all other linear body measurements for Marshall broiler chicken were positive and highly significant ($P<0.01$) and mostly close to unit. The highest relationship was observed between body weight and body length (0.96) while correlation between wing length and breast width (0.72) was obtained as the lowest. The correlation obtained varied from $r = 0.72$ to $r = 0.96$. However, the body weight and linear body measurements for Arbor acre revealed that the correlation observed ranged from $r = 0.73$ to $r = 0.95$. The correlation between body weight and other linear body measurements were positive and highly significant ($P<0.01$). The highest relationship was observed between body weight and body length (0.95) while the least correlation was observed between breast width and body length (0.73). Meanwhile, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacies were marvelous of values 0.92 and 0.90 for Marshall and Arbor acre broiler chickens, respectively while Bartlett's test of sphericities were significant (chi-squares 9026.63 and 8715.13) with determinants values of 1.37E and 2.39E at 0.05 for both Marshall and Arbor acre broiler chickens, respectively.

Table No.3 indicated the eigen values and percentages of total variance along with rotated component matrix and communalities of body conformation traits of Marshall and Arbor acre broiler chickens. The communalities obtained for Marshall varied from 0.97 (SHK) to 0.99 (WG). The eigen values revealed the amount of variance explained by each of the factors out of the total variance i.e 6.061 (PC1), 0.32 (PC2) and 0.29 (PC3). Three factors combined accounted for 95.28 % of the total variability present in the traits measured. PC1 had high loading on body length (0.82) and body weight (0.73) while PC2 being orthogonal to PC1, loaded highly on keel length (0.73) while PC3 has its loading highly at breast width (0.83). However, the Arbor acre communalities were ranged from 0.94 (SHK) to 0.99 (BDW, BDL, BRW and TH). The eigen values were 6.051, 0.38 and 0.19 for PC1, PC2 and PC3, respectively. Total variability for the three factors present in the variables measured was 94.82 % while PC1 had high loading on KL (0.76) and WG (0.73) with PC2 loaded highly on breast width (0.87) and PC3 loaded highly on BDL (0.75).

DISCUSSION

The present results on the descriptive statistics on the body weight and linear body measurements of the birds revealed that the measured traits were heavier than those earlier reported by Ojedapo *et al*, (2016)[11] in Cobb and Marshall broiler chickens in derived savanna region of Nigeria. The ranges of values for body weight, body length, keel length, breast width, thigh length, shank length and wing length were better to the findings of Ojedapo *et al*, (2010)[12], Amao *et al*, (2011)[13] and Amao *et al*, (2012)[3] in Anak, Wadi- Ross and Marshall broiler chickens respectively. These variations in the documentations of earlier workers might due to the differences in the genetic makeup of the birds and environmental factors where the birds are reared.

The correlation coefficient of the body weight and linear body measurements of Marshall and Arbor acre broiler chickens revealed the body weight had a positive and highly significant relationship with all the other variables measured. These observations were in accordance with the findings of Egena *et al*, (2014)[14], Yakubu *et al*, (2009)[15] and Ajayi *et al*, (2008)[16]. These authors observed that body weights were highly related to all the other linear body measurements of the chickens with increases in any of the body measurements will definitely lead to a corresponding increase in the body weight of the chickens. They all further concluded that the strong correlation between body weight and other linear body measurements were useful as selection criterion.

Meanwhile, the obtained high value of Kaiser-Meyer-Olkin measure of sampling adequacy (0.92 and 0.90) implies that the relationships between the traits measured were not related to the remaining traits outside each sample correlation. These KMO values of 0.92 and 0.90 were said to be marvelous by Kaiser (1960)[17] while Bartlett's test of sphericity for the body measurements of the broilers gave important information of using factors analysis for the set of data used in this study. The high communalities observed presently were similar to the findings reported by Mendes (2011)[18], Udeh and Ogbu (2011)[19] and Ajayi *et al,* (2012)[20] for different breeds of broiler chickens in respective of different environmental conditions of the birds. The PC1 for Marshall birds were highest variability relationship with body weight and body length while PC1 for Arbor acre birds revealed highest relationship with keel length and wing length. These observations were in harmony with the earlier works of Ajayi *et al*, (2012)[20] in broiler chickens and Egena *et al*, (2014)[14] in Nigerian local chickens. These authors and many others claimed that PC1 can be used as a single predictor while PC2 and PC3 combination could only led to small amount of variance explained for improvement in chickens.

Table No.1: Descriptive statistics of body weight and linear body measurements of Marshall and Arbor ace broiler chickens

S.No	Variable	Mean	SD	Min	Max	CV %
	Marshall					
1	BDW	1.63	0.61	0.10	2.10	58.86
2	BDL	20.76	7.85	9.00	38.00	37.83
3	KL	10.47	4.26	1.00	16.00	40.63
4	BRW	3.07	1.42	1.00	6.00	46.08
5	TH	10.09	2.94	1.00	15.00	29.17
6	SHK	11.85	3.07	6.00	17.00	25.92
7	WG	23.08	6.53	8.00	35.00	28.29
Arbor acre						
8	BDW	1.91	0.58	0.10	2.20	63.16
9	BDL	20.63	8.64	9.80	35.00	88.95
10	KL	10.52	4.33	1.00	17.00	41.18
11	BRW	3.24	1.29	1.00	6.00	39.75
12	TH	10.13	3.11	4.00	15.00	30.69
13	SHK	11.67	3.03	5.00	18.00	25.93
14	WG	22.30	6.56	8.00	34.00	29.41

BW = body weight, BDL = Body length, KL = keel length, BRW = Breast width, TH = Thigh length, SHK = shank length, WG = wing length, CV % - Coefficient variation

Table No.2: Correlation coefficient of body weight and body measurements of Marshall and Abor acre broiler chickens

S.No	Variable	BDW	BDL	KL	BRW	TH	SHK	WG
	Marshall							
1	BDW	1.00						
2	BDL	0.96	1.00					
3	KL	0.87	0.84	1.00				
4	BRW	0.73	0.68	0.78	1.00			
5	TH	0.87	0.84	0.85	0.81	1.00		
6	SHK	0.88	0.89	0.91	0.74	0.87	1.00	
7	WG	0.87	0.89	0.93	0.72	0.85	0.91	1.00
Arbor acre								
8	BDW	1.00						
9	BDL	0.95	1.00					
10	KL	0.89	0.83	1.00				
11	BRW	0.78	0.73	0.79	1.00			
12	TH	0.79	0.78	0.78	0.74	1.00		
13	SHK	0.95	0.91	0.91	0.81	0.79	1.00	
14	WG	0.92	0.89	0.93	0.79	0.77	0.93	1.00

BW = body weight, BDL = Body length, KL = keel length, BRW = Breast width, TH = Thigh length, SHK = shank length, WG = wing length

Table No.3: Eigen values and percentage of total variance along with the rotated component matrix and communalities of body weight and other linear measurements of Marshall and Arbor acre broiler chickens

S.No	Variable	PC1	PC2	PC3	Communalities
	Marshall				
1	BDW	0.45	0.34	0.49	0.99
2	BDL	0.46	0.29	0.75	0.99
3	KL	0.76	0.42	0.29	0.98
4	BRW	0.32	0.87	0.24	0.99
5	TH	0.41	0.46	0.37	0.99
6	SHK	0.65	0.33	0.45	0.94
7	WG	0.73	0.33	0.47	0.96
8	Initial eigen values	6.051	0.39	0.19	
9	% variance	86.45	5.56	2.81	
10	% cum. variation	86.45	92.01	94.82	
Abor acre					
11	BDW	0.73	0.43	0.36	0.98
12	BDL	0.82	0.31	0.29	0.98
13	KL	0.44	0.73	0.37	0.98
14	BRW	0.34	0.31	0.83	0.98
15	TH	0.37	0.29	0.31	0.98
16	SHK	0.64	0.51	0.41	0.95
17	WG	0.59	0.61	0.38	0.99
18	Initialeigen values	6.061	0.32	0.29	
19	% variance	86.59	4.59	4.59	
20	% cum. variation	86.59	91.18	95.28	

BW = body weight, BDL = Body length, KL = Keel length, BRW = Breast width, TH = Thigh length, SHK = Shank length, WG = Wing length

CONCLUSION

The study employed the uses of Principal Component Analysis (PCA) for analysis of the body traits in broiler chicken rather than on individual basis and this lead to the uses of independent orthogonal indices PC1, PC2 and PC3 which were more accurate than the adoption of original interrelated linear type traits for determined the body weight of chickens. The resultant three PCAs in each genetic group could assist in selection and breeding programme of broiler chickens especially in this southern guinea savanna zone of Nigeria.

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CONFLICT OF INTEREST

I declare that I has no conflict of interest.

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