APPLICATION OF PRINCIPAL COMPONENT ANALYSIS APPROACH TO EVALUATE BODY WEIGHT AND MORPHOMETRIC TRAITS OF NEW ZEALAND RABBITS BREED IN SEMI-ARID REGION OF NIGERIA

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ABSTRACT
This study was conducted to evaluate body weight and morphometric traits of New Zealand rabbits using principal component approach. Data were taken on body weight (BWT), body length (BL), ear length (EL), tail length (TL), heart girth (HG) and abdominal circumference (AC) on individual animals. Data collected were subjected to multivariate statistical analysis using SPSS 20.0 statistical package procedures. The results showed that sex had significant ($P<0.05$) effect on all the variables examined, with higher values recorded for female rabbits (1.01 kg, 28.53 cm, 10.53 cm, 8.70 cm, 20.30 cm and 22.28 cm for BWT, BL, EL, TL, HG and AC respectively) while males had lower values (0.80 kg, 26.15 cm, 9.96 cm, 7.99 cm, 18.80 cm and 20.33 cm for BWT, BL, EL, TL, HG and AC respectively). This trend reveals the manifestation of sexual dimorphism among the rabbit breeds in favour of female rabbits. The phenotypic correlation coefficient values (r) between the morphometric traits were all high and positive, ranging from r = 0.406 (between EL and BL) to r = 0.909 (between AC and HG). HG being the most correlated with BWT (r = 0.786) while the lowest correlation was between BWT and EL (r = 0.462). Two principal components (PCs) from the factor analysis of morphometric traits explained about 80.42% of the total variance. PC1 accounted for 64.46% while PC2 accounted for 15.97% of the total variance. Three variables, representing body conformation, loaded highest in PC1. PC1 had the highest contribution (64.46%) to the total variations and it is regarded as body conformation traits. The results revealed that morphometric traits can be used as aids to selection in rabbit genetic improvement programme.
Key words: Conformation, multicollinearity, multivariate, rabbits and principal component analysis.

INTRODUCTION
Rabbit production plays important role in increasing animal protein supply in Nigeria. Rabbit production provides a cheap, affordable and healthy source of meat (Ajala and Balogun 2004). Growth in farm animals involves an increase in body weight, which can change the conformation of various parts of the body. Live weight and linear measurements are indicators of growth rate carcass characteristics in rabbits (Ogah, 2011) and other farm animals.

In Nigeria, the commonest breeds include the New Zealand white and Californian amongst others. These two breeds are amongst the breeds available for meat production in Nigeria (Aduku and Olukosi, 1990) due to rapid weight gain (Bombeke *et al*., 1975).

Multicollinearity occurs when there is very high inter correlations among predictor variables (Shahin and Hassan, 2000). It can occur when the variables in the data set are highly correlated to each other and this can lead to unreliable partial regression coefficients. This can be reduced substantially by adopting principal component analysis (PCA) multivariate procedure. There is no information on the use of multivariate technique to describe the relationship between body weight and linear measurements in New Zealand rabbits raised under semi-arid condition in Nigeria.

However, authors have used PCA to describe the relationship among morphological traits in composite rabbits reared in southern Nigeria (Ajayi and Oseni, 2012) and crosses of New Zealand White x Chinchilla rabbits (Yakubu and Ayoade, 2009).

The objectives of this study therefore, were to evaluate morphometric traits of New Zealand rabbit breed reared under semi-arid condition in Nigeria and to determine morphometric traits that best describe body conformation for selection and breeding purposes using principal component analysis.

MATERIALS AND METHODS
The study was conducted at Teaching and Research Farm, Rabbitary Unit, Department of Animal Science, Federal University Dutsin-Ma, Katsina State, Nigeria. Dutsin-Ma is located within the semi-

arid region of Nigeria. Dutsin-Ma lies between latitude $12^0$27' and longitude $7^0$29' (Distancesfrom.com).

A total of eighty (80) 12-weeks old New Zealand rabbits breed (40 does and 40 bucks), comprising of equal sex, were used for this study. Animals were housed in individual cages constructed with wooden materials. Feed and clean drinking water were supplied *ad libitum* to the rabbits. All the necessary medications were administered appropriately. Data measured on individual rabbits include body weight (BWT), body length (BL), ear length (EL), tail length (TL), heart girth (HG) and abdominal circumference (AC).

Data obtained were subjected to analysis of variance using statistical package SPSS version 20.0.0. Pearson's correlation coefficients among the different variables were estimated. Principal component analysis was conducted to identify those morphological variables that could sufficiently describe the morphological characteristics of the rabbit population studied.

RESULTS

Table 1 show the descriptive statistics of the body weight (kg) and linear body measurements of does and bucks rabbits. Results of the present study showed that sex significantly ($p<0.05$) affected body weight with female rabbits recording higher values (1.01 and 0.80 respectively). Sex also had significant ($P<0.05$) effects on all the morphometric traits. Values obtained in all the morphometric traits were significantly ($p<0.05$) higher in female rabbits than male rabbits. Coefficients of variation (CV) values were low, ranging from 0.09 to 0.29 for all the traits measured.

Table 1: Descriptive statistics of the body weight (kg) and linear body measurements (cm) in New Zealand rabbits

Parameters	Sex	N	Mean	S.E	CV	S. D.
BWT	Female	40	1.01[a]	0.04	0.26	0.26
	Male	40	0.80[b]	0.04	0.29	0.23
	Total	80	0.91	0.03	0.29	0.26
BL	Female	40	28.53[a]	0.69	0.15	4.39
	Male	40	26.15[b]	0.49	0.12	3.12
	Total	80	27.34	0.44	0.15	3.97
EL	Female	40	10.53[a]	0.17	0.10	1.06
	Male	40	9.96[b]	0.20	0.13	1.25
	Total	80	10.24	0.13	0.12	1.19
TL	Female	40	8.70[a]	0.21	0.15	1.30
	Male	40	7.99[b]	0.20	0.16	1.27
	Total	80	8.35	0.15	0.16	1.32
HG	Female	40	20.30[a]	0.31	0.10	1.96
	Male	40	18.80[b]	0.31	0.11	1.98
	Total	80	19.55	0.24	0.11	2.10
AC	Female	40	22.28[a]	0.32	0.09	2.05
	Male	40	20.33[b]	0.35	0.11	2.21
	Total	80	21.30	0.26	0.11	2.34

BWT = body weight, BL = body length, EL = ear length, TL = tail length, HG = heart girth and AC = abdominal circumference, SD = standard deviation, SE = standard error, CV = coefficients of variation, [a,b]Means in the same column followed by different superscripts are significantly different ($P<0.05$)

The correlation coefficients values (r) between body weight and morphometric traits is presented in Table 2. The correlation values obtained were positive and ranged from r = 0.406 (between EL and BL) to r = 0.909 (between AC and HG). Highest value (r = 0.786) was recorded between BWT and HG.

Table 2: Phenotypic correlation among body weight and linear body measurements of New Zealand rabbits.

	BWT	BL	EL	TL	HG
BL	0.623**	1			
EL	**0.462****	0.406**	1		
TL	0.516**	0.529**	0.651**	1	
HG	**0.786****	0.514**	0.471**	0.501**	1
AC	0.775**	0.561**	0.457**	0.522**	0.909**

**Correlation is significant at the 0.01 level (2-tailed), BWT = body weight, BL = body length, EL = ear length, TL = tail length, HG = heart girth and AC = abdominal circumference.

Results of the principal component analysis showed that 5 principal components (PCS**)** explained total variance in the body conformation (Table 3). Joliffe cut off point of 0.80 eigenvalues showed that two PCS accounted for 80.42% of the total variations.

Table 3: Eigenvalues and contributions in each Principal Components

Component	Eigenvalues	Variance (%)	Cumulative (%)
1	3.22	64.46	64.46
2	0.80	15.97	80.42
3	0.56	11.28	91.70
4	0.33	6.53	98.23
5	0.09	1.77	100.00

Table 4 shows the PCA for New Zealand rabbits used in this study. The communalities ranged from 0.55-0.93. The two principal components extracted accounted for 80.42% of the total variance in New Zealand rabbits assessed. PC1 contributed 64.46% while PC2 contributed 15.97% of the total variances. Three variables with heaviest loadings in PC1 (64.46%) are BL, HG and AC (0.58, 0.92 and 0.93 respectively). Two highest loadings variables in PC2 (15.97%) are 0.88 and 0.84 for EL and TL respectively.

Table 4: Factor loadings, communalities, eigenvalues and proportion of total variation of factors

Parameters	Component		Communalities
	1	2	
BL	**0.58***	0.46	0.55
EL	0.21	**0.88***	0.81
TL	0.32	**0.84***	0.81
HG	**0.92***	0.25	0.91
AC	**0.93***	0.26	0.93
Eigenvalues	3.22	0.80	
Variances (%)	64.46	15.97	

BL = body length, EL = ear length, TL = tail length, HG = heart girth and AC = abdominal circumference.

DISCUSSION

The mean body weight (0.91 kg) obtained for both sexes in this study is lower than value (1880±22 g) obtained by Ajayi and Oseni (2012) for composite rabbits and the value (2920 g) reported by Yakubu and Ayoade (2009) in a cross of New Zealand White and Chinchilla rabbits. Coefficients of variation (CV) were low for all traits of both sexes. The present experimental rabbits were raised under semi-arid condition therefore the discrepancy observed could be attributed to differences in age, location and or genotype.

The observed higher values in all the parameters in does is contrary to the report of Ajayi and Oseni (2012) who observed that sex had no significant (P>0.05) effect on these traits. They however observed higher values for bucks. This sexual dimorphism can be attributed to the usual differential hormonal action which invariably leads to differential growth rates (Baeza *et al*., 2001).

The present study confirms the principle of sexual dimorphism in New Zealand rabbits. High and positive significant correlations coefficient value between BL, HG and AC with BWT were observed (Table 3). This may provide a more realistic prediction of BWT compared to other morphometric traits studied. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy for correlation matrix was found to be 0.738, which is above the recommended limit 0.50 (Kaiser, 1974).

Principal component analysis is a data reduction analysis used to reduce variables into few components. This also helps to provide better understanding of the extent of the relationship between traits by reducing the effects due to multicollinearity. High communalities values (ranging from 0.55–0.93) were observed in this present study (Table 4). The results obtained in this study are similar to those obtained by other authors (Egena *et al.,* 2014; Musa *et al.*, 2018). Two PCs were extracted in this study. Three traits with heaviest loadings in PC1 are BL, HG and AC. These traits are body conformation traits. Two traits with the highest loadings in PC2 are EL and TL. This is not in consonance with report of Ajayi and Oseni (2012) who extracted four PCs in composite rabbits and three PCs by Musa *et al.* (2018) for indigenous chickens. This report confirms that PC1 is essential body conformation.

CONCLUSIONS

The two principal components (PC) accounted for 80.42% of the total variances in morphological traits evaluated for this rabbit breed. The first PC included BL, HG and AC while the second PC included EL and TL.

REFERENCES

Aduku, A.O. and Olukosi, J.O. (1990). Rabbit Management in the Tropics: Production, Processing, Utilization, Marketing, Economics, Practical training, Research and Future Prospects, Living Book Services, G.U. Publications, Abuja. 24pp.

Ajala, M.K. and Balogun, J.K. (2004). Economics of rabbit production in Zaria, Kaduna State. *Tropical Journal of Animal Science*, 7(1), 1-10.

Ajayi, B.A. and Oseni, S.O. (2012). Morphological characterisation and principal component analysis of body dimensions in Nigerian population of adult rabbits. World Rabbit Science Association. *Proceedings of 10th World Rabbit Congress.* September 3–6. Sharm El-Sheikh –Egypt, 229–233.

Baeza, E., Williams, N., Guemene, D. and Duclos, M.J. (2001). Sexual dimorphism for growth in Muscovy duck and changes in insulin-like growth factor I (IGF- I), growth hormone (GH) and triiodothyronine (T3) plasma levels. *Reprod. Dev.*, 41: 173 - 179.

Bombeke, A., Okerman, F. and Moermans, R.J. (1975). Etude comparative de differentes races de lapins de chair. *Rev. Agric.* 28 (2): 421- 438.

Distancesfrom.com. A Distance Calculator. Assessed 2019-07-02.

Egena, S.S.A., Ijaiya, A., Ogah, D.M., Aya, V.E. (2014). Principal component analysis of body measurements in a population of indigenous Nigerian chickens raised under extensive management system. *Slovak Journal of Animal Science*, 47(2), 77 – 82.

Johnson, R.A. and Wichern, D.W. (2001). Applied Multivariate Statistical Analysis. Sixth edition. 794pp.

Jolliffe, I.T. (2002). Principal Component Analysis. 2nd Edn., Springer-Verlag, New York, USA. 518pp.

Kaiser, H.F. (1974). An index of factorial simplicity. *Psychometrika*, 39(1), 31-36.

Musa, A.A., Abdulmalik, S.E., Shoyombo, A.J., Akinsola, O.M. and Usman, T. (2018). Morphological characterization of Nigerian chicken genotypes using multivariate analyses. *International Journal of Poultry Science*, 17 (11), 560-567.

Ogah, D.M. (2011). Assessing size and conformation of the body of Nigerian indigenous turkey. *Slovak Journal of Animal Science*, 44 (1), 21-27.

Shahin, K.A. and Hassan, N.S. (2000). Sources of shared variability among body shape characters at marketing age of New Zealand White and Egyptian rabbit breeds. *Ann. Zootech*., 49(5), 435–445.

Yakubu, A. and Ayoade, J.A. (2009). Application of principal component and factor analysis in quantifying size and morphological indices of domestic rabbits. *International Journal of Morphology*, 27(4), 1013-1017.