sciendo DOI: 10.2478/ats-2020-0018 AGRICULTURA TROPICA ET SUBTROPICA, 53/4, 183–186, 2020

Original Research Article

Use of discriminant analysis method to identify sex by morphological traits in adult rabbits in Nigeria

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Abstract

Sex assessment plays an important role in rabbit production, but it can be very difficult to determine, especially in the young ones. In this study, canonical discriminant analysis was used to determine which of the morphological traits are the most effective in sex determination in rabbits. Data were taken on 160 rabbits and used for this study on body weight (BWG), body length (BDL), ear length (EAL), heart girth (HTG), and abdominal circumference (ABC). The results from the univariate analysis show manifestation of sexual dimorphism with higher values observed in females for all the morphometric measurements. The canonical discriminant analysis revealed that ABC was the most significant morphological trait as a discriminating variable between the sexes in rabbits. The discriminant function, D = – 8.673 + 1.865 BWG + 0.013 BDL + 0.291 EAL – 0.318 HTG + 0.463 ABC, obtained correctly classified 72.5% of individuals of rabbits. In conclusion, the abdominal circumference of the rabbits in a population could be an important tool for the conservation and improvement of the rabbits' population.

Keywords: Discriminant analysis; morphological traits; abdominal circumference; rabbits; sexes.

INTRODUCTION

Rabbit production has the potential to bridge the gap of animal protein deficiency in Nigeria (Ajala and Balogun, 2004). Rabbit is characterised by high nutritional and healthful meat, with low fat and cholesterol and high level of protein (about 20.8%), which makes it one of the healthiest meats for human consumption. However, it is also very favourable that its consumption is not frowned by many cultures and religions (Aduku and Olukosi, 1990; Biobaku and Oguntona, 1997). Rabbit possesses several potentials and veritable attributes, some of which include fast growth rate, ability to convert forage to meat efficiently, short gestation period, and high prolificacy (Obike and Ibe, 2010; Simeon, 2014).

Morphological variation within species is of great biological interest for the descriptive and analytical tool. Sexual dimorphism in morphological traits is important in descriptive studies to characterise population composition and evaluate the genetic variation within and between populations of rabbits.

In Nigeria, morphological measurements have been studied in adult rabbits (Chineke et al., 2006; Ajayi and Oseni, 2012; Ebegbulem, 2012). The differences in morphological traits between sexes in different studies have been attributed to sexual dimorphism (Gatford et al., 1998; Shahin and Hassan, 2002). However, there has been no report on the use of discriminant analysis procedures to identify sex using morphological traits in adult rabbits in Nigeria. This study, therefore, aimed to investigate sexual dimorphism in rabbits using morphological traits through discriminant analysis procedures. The information obtained could be used in the selection program of the rabbit population.

MATERIAL AND METHODS

This work was conducted in Livestock Teaching and Research Farm of Animal Science Department, Federal University Dutsin-ma. Dutsin-ma lies within Latitude 12°27' N and Longitude 7°29' E. The average annual temperature ranges from 29 °C – 31 °C. The highest temperature occurs between April and May and

Table 1. Means (+S.E) of the body weight and morphological traits of rabbits

Indicators	Sex	N	Mean	S.E
BWG (kg)	Male	80	0.80[b]	0.03
	Female	80	1.01[a]	0.03
	Overall	160	0.91	0.02
BDL (cm)	Male	80	26.15[b]	0.35
	Female	80	28.75[a]	0.40
	Overall	160	27.45	0.29
EAL (cm)	Male	80	9.88[b]	0.12
	Female	80	10.53[a]	0.12
	Overall	160	10.21	0.09
HTG (cm)	Male	80	18.80[b]	0.22
	Female	80	20.30[a]	0.22
	Overall	160	19.55	0.17
ABC (cm)	Male	80	20.33[b]	0.25
	Female	80	22.28[a]	0.23
	Overall	160	21.30	0.18

BWG = body weight, BDL = body length, EAL = ear length, HTG = heart girth, ABC = abdominal circumference, [a,b]Means with different superscripts between rows are significantly different at $P < 0.05$.

Table 2. Correlation coefficient matrix between body weight (kg) and linear body measurements in adult rabbits

	BWG	BDL	EAL	HTG	ABC
BWG	1	0.636**	0.061	0.784**	0.762**
BDL	0.823**	1	0.111	0.564**	0.584**
EAL	0.691**	0.696**	1	0.196	0.106
HTG	0.717**	0.558**	0.604**	1	0.870**
ABC	0.705**	0.677**	0.591**	0.918**	1

BWG = body weight, BDL = body length, EAL = ear length, HTG = heart girth, ABC = abdominal circumference, Upper diagonal = does, lower diagonal = bucks, $^{**}P < 0.01$.

the lowest from December to February (Abaje et al., 2014).

A total of 160 rabbits, comprising of 80 bucks and 80 does, were used for this study. Traits measured included the body weight (BWG), body length (BDL), ear length (EAL), heart girth (HTG), and abdominal circumference (ABC). Measurements were taken according to the species' classification descriptors (FAO, 2012).

The data collected were analysed to evaluate the effect of sex using the procedures of SPSS 20.0 (2011) statistical package. Pearson Correlation Coefficient was used to evaluate the relationships between the body weight and linear body measurements. The multivariate technique of canonical discriminant analysis procedure was used to identify relationships between sex and morphological characteristics of rabbits. The standardised discriminant function was applied to search for the most discriminating variables between the sexes with minimal error. The unstandardised discriminant function procedure was used for sex identification. Split-sample validation (leave-one-out) procedures of the SPSS statistical package was used to test the reliability of the function.

RESULTS AND DISCUSSION

Mean (±S.E) of the variables measured are shown in Table 1. The result shows significant ($P < 0.05$) differences between sexes in all the variables measured. There was the manifestation of sexual dimorphism in the rabbits with the female having higher values in all the traits. This report agrees with the results of other authors (Dalle Zotte et al., 2012; Salisu and Iyeghe-Erakpotobor, 2014). This trend could be attributed to the differential growth rates due to differential hormonal action between sexes (Okpeku et al., 2011).

The phenotypic correlation coefficients between the body weight and morphological measurements are shown in Table 2. In male rabbits, high and positive correlation coefficient values were recorded (ranging from 0.558 to 0.918) at $P < 0.01$ while the values in female rabbits range from low to high (ranging between 0.061 and 0.870). The body weight was highly correlated with body length, heart girth, and abdominal

Table 3. Standardised canonical discriminant function coefficients of the body parameters in rabbits

Traits	Function 1
Body weight	0.446
Body length	0.044
Ear length	0.309
Heart girth	–0.622
Abdominal circumference	0.981
Function at centroids	
Male	–0.518
Female	0.518
Summary of Canonical Discriminant Functions	
Eigenvalue	0.277
Variance explained (%)	100.00
Wilk's Lambda	0.787
Chi-squares	37.326
P value	0.000

Table 4. Classification results of discriminant analysis

		Sex	Predicted		Total (N)
			Does	Bucks	
Original	N	Does	58	22	80
		Bucks	22	58	80
	%	Does	72.5	27.5	100.0
		Bucks	27.5	72.5	100.0
Cross-validated	N	Does	58	22	80
		Bucks	22	58	80
	%	Does	72.5	27.5	100.0
		Bucks	27.5	72.5	100.0

circumference at $P < 0.01$ in both sexes. However, low value was recorded between body weight and ear length in does (0.061) but average in bucks (0.691). The high and positive correlations among the traits can be an indication that the traits are pleiotropic (Ogah et al., 2009). The high and positive phenotypic correlations observed among the morphological traits indicate high genetic variation, which supports high selection response (Yakubu, 2011). If selection is done for any of these traits, there would be a corresponding improvement in the body weight.

Table 3 shows the single standardised canonical discriminant function extracted in this study. The standardised canonical correlation coefficients show the individual contribution of independent variables to the prediction of the dependent variable. In this study it was found that the abdominal circumference was the most contributing variable to the model because its standardised canonical discriminant function was the highest (0.981). This shows that abdominal circumference is a highly important variable to determine sex. Some authors have used discriminant analysis for sex separation in Rose-coloured starlings *Sturnus roseus* (Zenatello and Kiss, 2005), African Muscovy ducks (Yakubu, 2011), and other birds (Martinez-Gomez and Curry, 1998; Lo Valvo, 2001).

The unstandardised canonical discriminant function was applied for the classification of individual rabbits. The variables included in the discriminant (D) equation are: body weight (BWG), body length (BDL), ear length (EAL), heart girth (HTG) and abdominal circumference (ABC), as shown below:

$$D = -8.673 + 1.865\ BWG + 0.013\ BDL + 0.291\ EAL - 0.318\ HTG + 0.463\ ABC$$

The predicted classification function of sexes of the measured individuals according to the discriminant function are presented in Table 4. The discriminant function was able to correctly classify 72.5% of the males and females, respectively, while 27.5% of the male and the female rabbits were wrongly classified.

CONCLUSION

This study revealed the manifestations of sexual dimorphisms in the morphological traits of the rabbits. Phenotypic correlation coefficients values observed between the morphological traits and body weight were all positive and ranged from low to high. Abdominal circumference was the most discriminating variable. The discriminant function was able to correctly classify 72.5% of the individuals. Information obtained from this study will aid in future conservation, selection and breeding programs.

CONFLICT OF INTEREST

Authors declare that there is no conflict of interest.

ACKNOWLEDGEMENT

This work was partly funded by Federal University Dutsin-ma, Katsina State, Nigeria. This is highly appreciated.

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Received: April 28, 2020
Accepted after revisions: November 27, 2020