MORPHOLOGICAL CHARACTERISATION AND PRINCIPAL COMPONENT ANALYSIS OF BODY DIMENSIONS IN NIGERIAN POPULATION OF ADULT RABBITS

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ABSTRACT

Body weight and linear body measurements were taken on 139 adult rabbits belonging to a composite population in south-western Nigeria. The objectives of this study were to define the body dimensions of adult heterogeneous rabbits and investigate the morphological variables that contribute to body conformation by the use of principal component analysis. Variables measured included body length, heart girth, ear length, ear width, tail length, face length, fore-arm length and shoulder length, thigh length and thigh circumference. Data were subjected to multivariate analysis using PAST®. Mean body weight of all animals was 1880 g with a range of 1500 to 2800 g indicating wide variability. In all, four principal components accounted for 86.85% of total variation in morphological traits for this rabbit population. Variables that make up the first principal component (PC1) which accounted for 55 % of the total variance are heart girth, hind-leg length and thigh length. The second PC (PC2) accounted for 13.74% of total variance included hearth girth, fore-arm length and hind-leg length, while PC3 included body length, fore-arm length and the thigh length and accounted for 10.70 %. Finally, this rabbit population showed no sexual dimorphism between the two sexes.

Key words: Rabbits, Nigerian population, morphological body conformation and Principal component analysis.

INTRODUCTION

Morphological differences exist among different breeds and populations of rabbits worldwide and detailed characterization and inventories are important in the conservation of rabbit genetic resources. One of the pre-requisites for genetic improvement of livestock species generally is the knowledge of detailed characterization reports of different breeds and composite populations in different locations worldwide. Lukefahr (1998) discussed genetic characterization of rabbit populations world-wide, with emphasis on the developed world. Bolet *et al*. (2008)

There are several reports on characterization efforts from different perspectives e.g. production: Tawfeek (1995), Zer rouki *et al*. (2007) and Oseni and Ajayi (2010). Detailed characterization data are already available for ten breeds in the report (Bolet *et al*. 1999).These include, Flemish Giant, French Lop, Belgian Hare, Vienna White, Champagne Argente, Thuringer. Others are Fauve de Bourgogne, Chinchilla, Himalayan and British rabbit. Several authors have used Principal component analysis in body morphological data analysis and compression in many animal studies. These included Anye *et al,* (2010) in guinea pigs and Yakubu *et al.* (2009) in Nigerian chickens, There has been no report on PCA on body measurements in composite rabbit population. Thus, the objectives of this study were to define the body dimensions of adult heterogeneous rabbits and investigate the morphological variables that control body conformation in this rabbit population.

MATERIALS AND METHODS

This study was conducted at the Obafemi Awolowo University Teaching and Research Farm, Ile-Ife, Osun State, Nigeria. Rabbits for this study were obtained from heterogeneous populations reared in farmers'

backyards in Ibadan, Osogbo and Ile-Ife in southwestern Nigeria. Heterogeneous rabbit stocks are products of non-specific crosses of breeds brought into sub-Saharan African countries which included, Alaskan, Blue Vienna, New Zealand White, California, Chinchilla and Checkered Giant. Others are Crème D'Argent, Champagne D'Argent, Dutch, Flemish Giant, French Lop, and Thuringer breeds (Opoku and Lukefahr 1990). A total of 139 adult rabbits with weights ranging between 1.5 to 2.8 kg. Animals were housed in cages made of wood and chicken wire mesh with each cell measuring $76 \times 62 \times 42$ cm and raised with wooden stands 90 cm high from concrete floor. The pen house was covered with chicken wire mesh at three of the sides and planks at one end, a store for feed at the other end and roofed with asbestos sheets. Two clay pots for feed and water, were placed in each hutch. Body weight in grammes and eleven linear body measurements (in centimeter) which included body length (or the diagonal distance from the point of the shoulder to the pin bone); heart girth (or the circumference of the thoracic cavity just behind the forelimbs); ear length (or the distance from the base of the ear to its tip); ear width (or the distance across the middle of the ear); tail length (or the distance from the pin bone to the tip of the tail); face length distance from the middle point to two eyes on the fore head to the tip of the nostril; fore-arm length, distance from the hock to the proximal end of the humerus, shoulder length the length of the scapular and hind-leg length distance from the proximal end to the femur to the distal end of the fibula. Other measurements included thigh length (the distance from the proximal end to the distal end of the femur) and thigh circumference (the circumference of the thigh muscles) according to the procedures of Akanno and Ibe (2006).

Measurements of morphological variables were taken on the experimental animals before feeding in the morning. Body weights were taken with a Camry® top loader weighing scale graduated in 10 g and the linear measurements taken with the aid of a Tailors' Rule with the side graduated in centimeters. All the measurements were taken by the same person.

Data were analyzed using the multivariate procedure components of PAST® software (Hammer *et al.* 2008). Principal component analysis was used to identify variables that could adequately describe the morphological characteristics of the adults of this composite rabbit population. The number of PC$_S$ to retain was determined using the elbow plot (Johnson and Wichem, 2001).

RESULTS AND DISCUSSION

Table 1 shows the linear body measurements and body weight of female and male rabbits. Mean body weight for the female was 1860 ±30 g while that of the male was 1910±42 g. The average for the two sexes was 1880±22 g is lower than the value reported by Yakubu and Ayoade (2009) who reported 2920 g in a cross of New Zealand White and Chinchilla rabbits. When subjected to multivariate analysis, there were no significant differences in the body measurements of the two sexes (Figure 3). Since the points for both females and the males clustered together and overlapped each other as shown in the Figure.

Table 1: Body measurements of adult female and male rabbits of heterogeneous population

Body measurement	n	Female Mean±SE	Min	Max	n	Male Mean±SE	Min	Max
Body weight (g)	93	1860 ±30	1500	2500	46	1910±42	1500	2800
Body length (cm)	93	32.20 ±0.19	28.00	36.00	46	32.43±0.29	28.00	37.00
Heart girth (cm)	93	28.87 ±0.40	21.00	36.00	46	27.54±0.56	22.00	36.00
Ear length (cm)	92	9.70 ±0.07	8.00	11.00	46	10.17±0.10	8.30	12.50
Ear width (cm)	92	5.74 ±0.06	5.00	8.70	46	5.62±0.05	5.00	7.00
Tail length (cm)	93	7.21±0.12	4.00	11.00	46	7.77±0.17	5.50	10.00
Face length (cm)	93	6.52±0.06	5.10	8.00	46	6.69±0.07	6.00	8.50
Forearm (cm)	92	10.77±0.17	7.00	15.00	46	11.15±0.24	9.00	15.00
Shoulder length (cm)	93	8.08±0.11	6.00	12.00	46	8.04±0.11	6.50	10.00
Hind-leg length (cm)	92	13.24±0.26	8.50	21.00	46	14.78±0.21	8.00	17.00
Thigh length (cm)	93	11.51±0.22	8.00	16.00	46	10.76±0.29	8.00	16.00
Thigh circumference (cm)	93	11.98±0.17	9.00	15.00	46	12.20±0.23	9.00	15.00

n = The number of observations, SE= Standard error of means, Min = Minimum value, Max = Maximum value

The results of the principal component analysis showed that 11 principal components (PC$_S$) will explain the total variance in the body conformation (Table 2). Joliffe cut off point of 2.49 in Table 2 showed that four PC$_S$ accounted for over 87 % of the total variance in the adult population. Figure 1 shows the scree (elbow)

plot indicating the cut-off point at PC 5 the point at which the curve flattens out. Each of the eigenvalues of PC_S 1to 4 had values that were above 5%. The traits with heaviest loadings in PC 1 (55.55 %) of total variance are heart girth, hind-leg length and thigh length with the following loadings: 0.79, - 0.44 and 0.34 respectively (Figure 2a). Three highest loadings in PC 2 are 0.55, 0.47 and 0.43 for hind-leg length, heart girth and fore-arm length respectively (Figure2b) accounted for about 14 %. The third PC loadings (Figure2c) accounted for 11 % included body length (0.89), fore-arm length (0.24) and the thigh length (0.23). Variables in PC four (Figure 2d) with highest loadings are thigh circumference, fore-arm length and thigh length with eigen loadings of 0.79, 0.52 and 0.20 that accounted for 7.41 %.

Table 2: Eigenvalues and the proportion of the total variance for derived components for adult population heterogeneous rabbits.

PC	Eigenvalue	% Varaince	Cummulative %
1	21.80	55.55	55.55
2	5.39	13.74	69.29
3	4.20	10.70	80.00
4	2.91	7.41	87.41
5	1.51	3.85	91.27
6	1.10	2.81	94.09
7	0.85	2.17	96.27
8	0.72	1.83	98.10
9	0.33	0.86	98.97
10	0.23	0.60	99.57
11	0.16	0.41	99.99

Jolliffe cut off point = 2.49
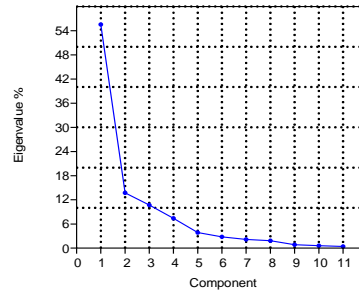

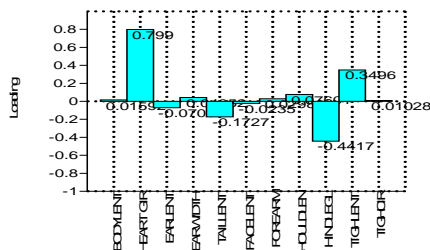Figure 2a: Scree plot for the morphological variables of adults heterogeneous rabbits
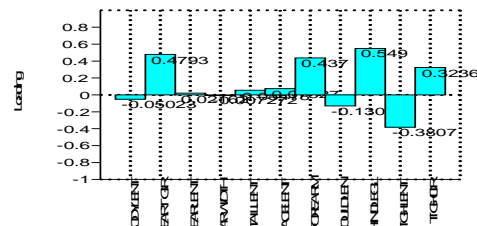

Figure 2b:Eigenvectors of PC_2

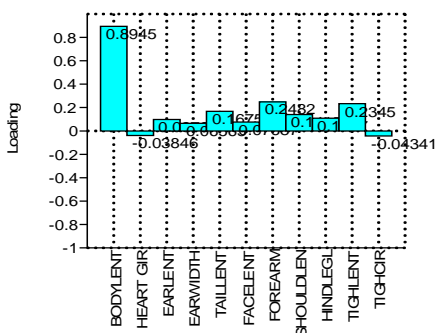Figure 2a:Eigenvectors (factor loadings) of PC_1

Figure 2d:Eigenvectors of PC_4
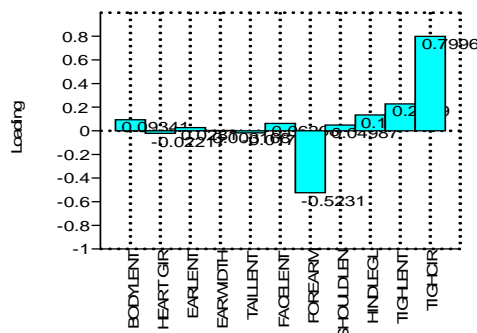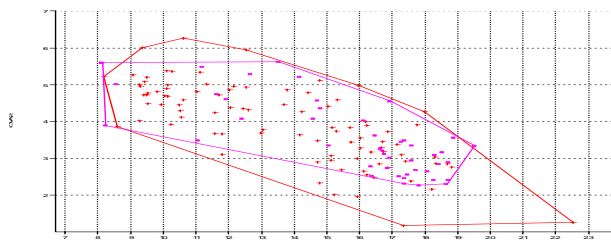

Figure 2c:Eigenvectors of PC_3

Figures 2a, b, c and d: **Eigen Loadings for adult population of Heterogeneous rabbit on $PC_{1 \text{ to } 4}$**

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Figure 3: Convex hulls diagram of multivariate analysis of variance (MANOVA) comparing body dimensions of sexes in adult heterogeneous rabbit population [Males = pluses (+); Females = closed squares (■)

shows the scree (elbow) plot indicating the cut-off point at PC 5 the point at which the curve flattens out. Each of the eigenvalues of PC_S 1to 4 had values that were above 5%. The traits with heaviest loadings in PC 1 (55.55 %) of total variance are heart girth, hind-leg length and thigh length with the following loadings: 0.79, - 0.44 and 0.34 respectively (Figure 2a). Three highest loadings in PC 2 are 0.55, 0.47 and 0.43 for hind-leg length, heart girth and fore-arm length respectively (Figure2b) accounted for about 14 %. The third PC loadings (Figure2c) accounted for 11 % included body length (0.89), fore-arm length (0.24) and the thigh length (0.23). Variables in PC four (Figure 2d) with highest loadings are thigh circumference, fore-arm length and thigh length with eigen loadings of 0.79, 0.52 and 0.20 that accounted for 7.41 %.

CONCLUSIONS

This study showed that four principal components (PC) accounted for 87 % of total variation in morphological traits for this rabbit population. The first PC included hearth girth, hind leg length and thigh length. The second PC included hearth girth, fore-arm length and hind-leg length. The third PC included body length, fore-arm length and the thigh length. Variables in PC four with highest loadings are thigh circumference, fore-arm length and thigh length. The Multivariate Analysis of variance of the linear body measurements showed no sexual dimorphism between the two sexes in the adults of this population.

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