COMPARATIVE STUDY OF MORPHOLOGICAL TRAITS OF ADULT MALE AND FEMALE WEST AFRICAN DWARF GOATS

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https://dx.doi.org/10.4314/gjansci.v15i1.2

ABSTRACT
Linear body measurements and live body weights were taken on two hundred (200) adult West African Dwarf (WAD) goats comprising of 115 does and 85 bucks from keeper's backyard in some selected communities (Iwata, Isundunrin and Ola) in Ejigbo Local Government Area of Osun State. The objectives of the study were to compare the morphological traits between sexes and describe the body morphology of adult WAD goats using a multivariate approach. Variables measured included: Body weight (BW), Face length (FL), Ear width (EW), Ear length (EL), Horn length (HL), Neck length (NL), Neck circumference (NC), Heart girth (HG), Body length (BL), Hind leg length (HLL), Tail length (TL) and Shoulder length (SL). Others were: Scrotal length (SCL) and Scrotal circumference (SCC) in bucks. Data obtained were subjected to univariate, Welch's t-test and multivariate analysis with the use of SAS (2002) to determine means, significant differences between means for different sexes and principal components of the variables in the sexes. Results showed that, the mean BW, FL, EW, EL, HL, NL, NC, HG, BL, HLL, TL and SL of does were: 15.05±0.49 kg, 18.88±0.26, 6.12±0.09, 10.46±0.17, 7.78±0.30, 17.16±0.38, 31.31±0.89, 52.05±1.42, 53.62±0.92, 43.43±1.81, 8.12±0.28 and 35.22±0.59 cm respectively. The corresponding values in bucks were: 14.06±0.32 kg, 19.44±0.20, 5.42±0.10, 9.97±0.17, 6.69±0.13, 14.32±0.14, 29.84±0.43, 51.55±0.60, 53.33±0.29, 40.87±1.20, 8.73±0.17 and 32.22±0.75 cm. The means for scrotal length and scrotal circumference in males were 8.73±0.16 and 17.66±0.17 cm respectively. Significant differences (p<0.001) were detected between most of the variables in the two sexes except in EW, EL and BL. Two principal components (PCs) of PC1 (50.1%) and PC2 (31.9%) were retained for does while three PCs 52%, 25% and 10% respectively were retained for bucks. Body length showed highest PC loadings for does in PC1 (0.95) whiles face length showed highest PC loadings for bucks in PC1 (0.97); suggesting that these variables are the most discriminating traits between the sexes. This study concluded that, sexual dimorphism was observed in the linear body measurements in the WAD goats; thus, does and bucks could be selected based on body length and face length respectively. The results herein could be used in evaluating the present goat population for selection programme.

Keywords: *morphological traits, linear body measurements, principal components analysis*

INTRODUCTION

Morphological studies on indigenous animal genetic resources are important components of phenotypic characterisation, which is a major tool for breed conservation and improvement programmes. Indigenous livestock breeds and populations (cattle, sheep, goats, pigs, etc.) are well adapted to their various local environments, especially under marginal production systems in terms of feed and health management at keepers' backyards in smallholder units. They contribute to improved livelihood among the rural dwellers and thus, morphological information about them needs to be well documented to facilitate genetic improvement of these breeds through selection and their characterisation. Goats have several advantages over other livestock species. Peacock (1996) stated that, they are relatively cheaper to acquire and they reproduce quickly. Chiejina and Behnke (2011) noted that, West African Dwarf (WAD) goats reared in Nigeria are known for their resistance to trypanosomiasis and intestinal nematode infections more effectively than any other known breed of goats. Several authors had used body weight and linear body measurements of farm animals for phenotypic characterisation and these include Yakubu *et al.* 2010 in WAD and Red Sokoto goats; Oseni and Ajayi (2014) in WAD goats; Wheto *et al.* (2015) in Nigerian goats; Dudusola *et al.* (2018) in WAD goats; Widya and Fahrul (2019) in Katyang does of Indonesia; Adamu *et al.* (2020) in Red Sokoto and Sahel goats; and Yakubu *et al.* (2021) in cattle. Others include Asamoah-Boaheng and Sam (2016) using three breeds of sheep in Ghana; Quattara *et al.* (2021) in indigenous Djallonke sheep in rural areas of southern Mali and Whannou *et al.* (2021) in indigenous sheep population of Benin.

Ogah (2011) and Oseni and Ajayi (2010) had described body measurements to reflect breed norms and provide information on the morphological structure and developmental capacity of animals. Everitt *et al.* (2001) had demonstrated Principal Component Analysis (PCA) as a multivariate method, which transforms the variables in a multivariate data set into new variables, which are uncorrelated with each other. They reported PCA as a valuable refinement and useful analysis to extract factors contributing towards variation between individual animals based on body measurements. There is however little information on the use of PCA in characterization of WAD goat populations in Nigeria. The objectives of this study therefore were to characterise the morphological features of WAD goats, determine differences in morphological traits in male and female sexes and describe the body morphology of the WAD goat using PCA.

MATERIALS AND METHODS

Study area

The study was carried out at Iwata, Isun´dunrin and Ola communities of Ejigbo. Ejigbo which lies approximately between latitude 7º54'00" north of the equator and 4º18'54" east of the Greenwich Meridian, is the headquarters of Ejigbo Local Government Area. The town is about 40 kilometres North West of the State Capital, Osogbo; 24 kilometres South East of Ede; 35 kilometres and 95 kilometres North East of Iwo and Ibadan (Oyo State Capital city) respectively (UN-HABITAT, 2014).

Data collection

Linear body measurements were taken on a total of 200 adult WAD goats (85 bucks and 115 does) ranging between 1 and 3 years old. The animals were selected randomly from smallholder livestock owners who practiced semi-intensive and extensive systems of management with uncontrolled mating across the study locations. There were no birth records of the animals therefore the ages of the animals were determined by dentition (FAO, 1999). Live body weights (LWB) were taken with the use of a digital scale and the linear body measurements were taken with the aid of a flexible measuring tape (tailors' tape) graduated in centimetres (cm). The linear body measurements were determined using the methods described by Hassan and Ciroma (1992). They included live body weight of the animal which was obtained by placing them on the weighing scale; Chest girth (CG) measured

as the circumference of the body, slightly behind the shoulders and perpendicular to the body axis; Body length (BL) measured from the tip of the scapula close to the neck region to the pin bone of the tail region; Head length (HL) measured from the tip of the skull at the mouth region to the point where the cervical vertebrae connect to the skull; Neck length (NL) being the entire region of the cervical vertebrae and Ear length (EL) measured from the point where the ear is attached to its tip. Horn length (HL) measured as the point of attachment of the horns to the head up to its tips; Tail length (TL) measured as the distance between the beginnings of the caudal vertebrae to its tip; Leg length (LL) measured as the distance from the tips of the hoofs to the point where the tarsal joined to the tibia and fibula.

Data Analysis

Statistical analysis was performed with SAS (2008) software. Descriptive data were presented as means and standard errors (SE). The Welch t-test was used to determine differences between the means of male and female goats. The principal component analysis was done using the factor procedure of SAS. The level of significance was set at $p<0.01$.

RESULTS AND DISCUSSION

Univariate analysis

Table 1 shows the means and standard errors for the body weight and linear body measurements of bucks and does. The results showed that the overall mean of live body weight for bucks (14.06±0.32 kg) was significantly (p=0.001) lower than that of does (15.05±0.49 kg). This may be due to the fact that majority of the sampled population had bucks within one and two years old while the does were between one to three years old. Another reason, which could have accounted for the lower weight of the bucks, is the loss of energy through excessive/ unnecessary indiscriminate mating as this is a common practice by bucks under semi-intensive and extensive systems of management. The results further indicate that body weight exhibits sexual dimorphism in goats which could be due to the fact that alleles controlling the trait may be limited or repressed in expression in the males at certain ages than the females (Botwe *et al*., 2023; Ofori *et al*., 2021). On the other hand, bucks and does in the present study did not show any significant difference in body length, contrary to the findings of Baffour-Awuah *et al.* (2000) and Egena (2010) who reported that, females had longer bodies in sheep and pigs respectively. Meanwhile, most of the means of the variables studied: face length, horn length, neck length, neck circumference, heart girth, shoulder length, hind leg, tail length, scrotal length and scrotal circumference were significantly different (p=0.001) for the two sexes and this partly confirms the findings of recent research on WAD goats by Ofori *et al*. (2021). Ear width (p=0.708) and ear length (p=0.122) however, were not significantly different, similar to the outcome of Ofori *et al*. (2021) who found no significant difference in the ear length of male and female WAD goats of Ghana. The average weight and average body measurements (heart girth, ear length, neck length, face length and neck circumference) in this study are within the ranges reported by Dudusola *et al.* (2018) but at variance with the report of Yakubu *et al.* (2010) in all the traits measured. This could be as a result of differences in location of the studies.

Principal component analysis

Table 2 shows the Eigen values and percentages of variance explained for bucks and does. Three principal components were retained for the bucks, whereby PC1 accounted for 52%, PC2 accounted for 25% and PC3 accounted for 10%. The three PCs retained therefore accounted for 87% of the total variation. Two PCs were retained for the does where PC1 accounted for 50% and PC2 accounted for 32% hence the two PCs accounted for a total of 82% of the total variation. The three PCs and two PCs retained for bucks and does respectively, were on the basis of the eigenvalues-greater-than-one rule (SAS, 2008). The outcome of the present work agrees with Dudusola *et al.* (2018) who reported

Table 1: Means ± standard error for body weight and linear body measurements of bucks and does of WAD goats

Traits	Mean (Buck N=85)	Mean (Doe N= 115)
Weight, kg	14.06±0.32[b]	15.05±0.49[a]
Face length, cm	19.44±0.20[a]	18.88±0.26[b]
Ear width, cm	5.42±0.10	6.12±0.09
Ear length, cm	9.97±0.17	10.46±0.17
Horn length, cm	6.69±0.13[b]	7.78±0.30[a]
Neck length, cm	14.32±0.14[b]	17.16±0.38[a]
Neck circumference, cm	29.84±0.43[b]	31.31±0.89[a]
Heart girth, cm	51.55±0.60[b]	52.05±1.42[a]
Body length, cm	53.33±0.29	53.62±0.92
Hind leg, cm	40.87±1.20[b]	43.43±1.81[a]
Tail length, cm	8.73±0.17[a]	8.12±0.28[b]
Shoulder length, cm	32.22±0.75[b]	35.22±0.59[a]
Scrotal length, cm	8.73±0.16	-
Scrotal circumference, cm	17.66±0.17	-

[1]*Means in rows with different superscripts are significantly different (p=0.001)*

Table 2: Eigenvalues and percentage of total variance explained for bucks and does

	Buck			Doe		
	Eigenvalues	**% Variance**	**Cumulative**	**Eigenvalues**	**% Variance**	**Cumulative**
1	6.73	0.52	0.52	5.51	0.50	0.50
2	3.19	0.25	0.77	3.50	0.32	0.82
3	1.34	0.10	0.87	0.86	0.08	0.90
4	0.91	0.07	0.94	0.47	0.04	0.94
5	0.39	0.03	0.97	0.34	0.03	0.97
6	0.19	0.01	0.98	0.15	0.01	0.98
7	0.13	0.01	0.99	0.08	0.00	0.99
8	0.04	0.00	0.99	0.04	0.00	0.99
9	0.03	0.00	0.99	0.02	0.00	0.99
10	0.02	0.00	0.99	0.01	0.00	0.99
11	0.01	0.00	0,99	0.00	0.00	1.00
12	0.01	0.00	0.99	-	-	-
13	0.00	0.00	1.00	-	-	-

that two PCs accounted for 73% for goats of two years, four PCs of goats between 2-3 years accounted for 73.5% and three PCs for goats of 3-4 years accounted for 64.9% of the total variance in morphological traits of goats studied in Osun state of South-western Nigeria. Similarly, Rotimi *et al.* (2020) reported that two PCs were retained both for male and female WAD goats in Benue state where PC1 accounted for 56.50% and PC2 accounted for 10.80% in does; and PC1 accounted for 55.48% and PC2 accounted for 11.52% of the variance in measured traits of bucks.

Table 3 shows the morphometric characteristics of the WAD goats in Ejigbo as explained by the three PCs for bucks and two PCs for does. The face length, ear width, horn length, neck circumference, heart girth, hind leg, tail length, scrotal length and scrotal circumference had high loadings for PC1 in bucks. PC1 had highest loadings for face length, PC2 had highest loadings for ear length and PC3 had highest loading for body length in bucks; indicating that these traits have higher discriminatory power (contributing significantly to the aggregate variation) and therefore might be considered as priority traits for differentiating bucks comparable to the results of Rotimi *et al*. (2020) who noted that PC2 had highest loadings (0.844) for ear length in males of WAD goats. The face length, ear length, heart girth, body length, tail length and hind leg had high loadings for PC1 in the does while ear width, shoulder length, horn length and neck circumference had high loadings in PC2 for the same set of does. However, the most discriminating traits for does were body length and shoulder length, which recorded highest loadings for PC1 (0.95) and PC2 (0.95) respectively, contrary to Rotimi *et al*. (2020) who found that the most differentiating traits for female WAD goats were heart girth and tail length, which recorded highest loadings for PC1 (0.827) and PC2 (0.893) respectively. Generally, sexual dimorphism was clearly observed in the PC loadings for the morphological traits between male and female goats in the current study. Consequently, as variation is the raw material for improvement through selection, it may be worthwhile to consider the most discriminating traits such as face length and body length in the selection of bucks and does respectively due to sexual dimorphism.

CONCLUSION

The means of variables measured in both bucks and does showed significance differences. Sexu-

Table 3: Retained principal components for bucks and does

Morphometric Variables	Bucks			Does	
	PC1	PC2	PC3	PC1	PC2
Face length	0.97	0.02	-0.04	0.83	0.46
Ear width	0.84	0.03	-0.36	0.42	0.69
Ear length	0.32	0.93	-0.03	0.86	-0.08
Horn length	0.65	0.59	-0.31	0.17	0.93
Neck length	0.84	0.11	0.33	-0.69	0.52
Neck circumference	0.76	-0.47	-0.31	-0.22	0.85
Heart girth	0.73	0.35	0.25	0.92	-0.19
Body length	0.29	0.50	0.74	0.95	0.11
Hind leg	0.70	-0.44	0.30	0.92	-0.09
Tail length	0.83	0.28	-0.41	0.86	0.03
Shoulder length	0.26	-0.87	0.08	-0.10	0.95
Scrotal length	0.77	-0.56	0.15	-	-
Scrotal circumference	0.91	-0.13	0.11	-	-

al dimorphism was observed in the linear body measurements and PC loadings for the male and female WAD goats. The body length showed highest PC loadings in female as compared to the male and therefore presented a good measure of selection for female WAD goats. On the other hand, face length showed highest PC loadings in male as compared to the female and therefore presented a good measure of selection for male WAD goats. The results herein could be used in evaluating the present goat population for selection programme.

ACKNOWLEDGEMENTS

The authors are grateful to the goat farmers in the study area for their cooperation for given us access to their goats.

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