International Research Journal of Agricultural Sciences Vol. 1(3) pp. 45-51, July 2013
Available online http://www.advancedresearchjournals.org/journal/irjas/

Full Length Research Paper

Principal component analysis of the morphostructure of Uda and Balami sheep of Nigeria.

A.J. Yunusa, A.E. Salako and O.A Oladejo*

Department of Animal Science, University of Ibadan, Ibadan, Nigeria
*Department of Animal Science and Fisheries, Bowen University, Iwo, Nigeria

Corresponding Author E-mail: alabajolaoye@gmail.com, Tel. +2347033236552

Abstract

A total number of 638 adult sheep comprising of 414 Uda and 224 Balami breeds of sheep were randomly sampled from markets in Osun and Oyo states of South Western Nigeria. 17 linear measurements were taken on the animals to classify these breeds of sheep. The characters measured include Rump Width (RW), Rump Length (RL), Tail Length (TL), Wither Height (WH), Heart Girth (HG), Pouch Girth (PG), Rump Height (RH), Ear Length (EL), Foreleg Length (FLL), Rear-leg Length (RLL), Body Length (BL), Shoulder Width (SW), Neck Circumference (NC), Head Length (HeL), Head Width (HW), Horn Length (HL), and Hock Length (HoL). Partial correlation of all variables, controlling for breeds, revealed that all variables but correlation of RH with FLL and RLL were highly significant. The significant correlation coefficients obtained from this study range from 0.250 to 0.870 (p<0.01). Principal component analysis of factor solution where two components that explained a tangible proportion of total variance were extracted revealed that 66.91% and 57.43% of the total variance were explained for Balami and Uda sheep respectively. With varimax rotation of component loadings, BL, WH, HG, RH, EW, TL, EL, HeL and HW loaded on the first components while RL, FLL, RLL, NC, HL and HoL loaded on the second components for Uda sheep. For Balami sheep, WH, HG, PG, RH, FLL, RLL, NC, HeL, HL and HoL loaded on the first component while BL, RW, RL, TL, SW and HW loaded on the second component. It was concluded that traits that are associated with bone development especially cranial measurements best describe the two breeds investigated.

Key word: Principal Component Analysis; Sheep morphostructure

INTRODUCTION

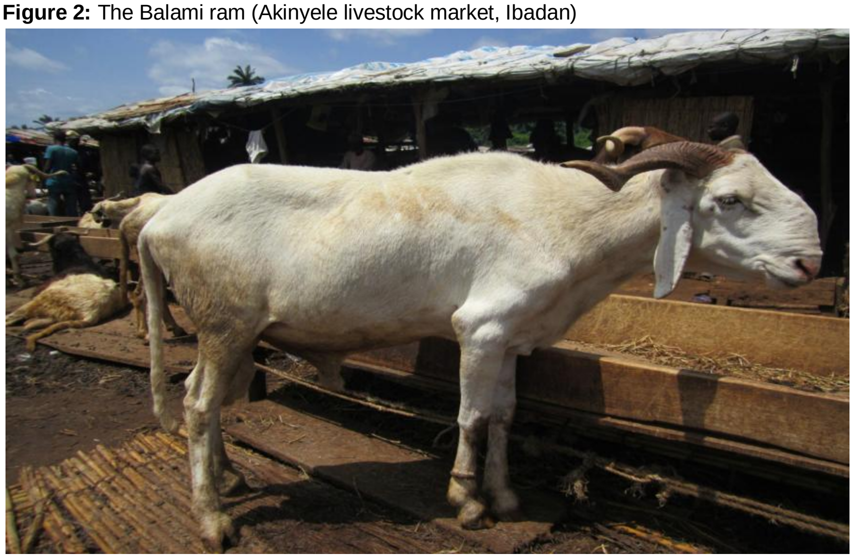
Genetic diversity of living organisms is the baseline for their survivability in a wide array of environments. Morphological conformation appraisal of livestock is probably the oldest way of information collection and it played a central role in many breeding associations and has been used with great success over years (Janssens and Vandepitte, 2004). Though morphological description of farm animal is largely influenced by environmental factors, this influence is reduced with good sampling technique and use of adequate sample size. Capenter (1979) also elucidated that visual appraisal is affected by individual biases and perceptual differences among observers, hence, the results obtained from morphological description may be complemented with both biochemical and DNA analysis. Body measurements have been widely used for estimating animal's live weight especially when there is no access to weighing equipment. Though its use has not been popular in sheep, swine and poultry production (Lawrence and Fower, 1997), it has been use to predict the weight of cattle with great success (*El* Khidir, 1980). Several parts of animal body have been measured for use but those parts that are directly related to bone development find more use because of lesser influence the environment have on them.

Balami and Uda sheep are the largest breed of sheep of Nigeria, traditionally reared in the arid region of North. Because of the large body size of these sheep and preference by the consumers, no breeding program on sheep can elude these breeds, therefore, there is need to study their morphostructure.

Principal component analysis (PCA) is an interdependence technique whose primary purpose is to define the underlying structure among the variables in the analysis. Broadly speaking, factor analysis provides the tools for analyzing the structure of the interrelationships

Figure 1: The Uda ram (Akinyele livestock market, Ibadan)

Figure 2: The Balami ram (Akinyele livestock market, Ibadan)



(correlations) among a large number of variables by defining sets of variables that are highly interrelated, known as factors (Hair *et al.,* 2010). These groups of variables which are by definition highly inter-correlated are assumed to represent dimensions within the data. Though the number of components generated in PCA equals the number of variables in the analysis, first few components account for the highest proportion of the total variance. PCA has been used as a tool in the assessment of the body shapes which could be of evolutionary significance as well as permit an understanding of the complex growth process going on among the body dimensions of an animal during growth period (Salako, 2006). PCA of some linear measurements and weight has been used with a view to describe pre-yearling body shapes in sheep (Brown *et al.,* 1973). Because of large demand and preference for mutton by Muslims, morphological classification with PCA will not only impact the management of these animals but also aid conservation and selection for multiple traits by breeders.

MATERIALS AND METHOD

A total number of six hundred and thirty eight (638) adult sheep comprising of four hundred and fourteen (414) Uda and two hundred and twenty four (224) Balami breed were randomly sampled from markets in Osun and Oyo states of South Western Nigeria. Most of these sheep were not traditionally managed in the region but were brought from Northern part of the country since these sheep are not indigenous to the trypano-endemic region of humid Southern Nigeria. The sheep consisted of three hundred and sixty-five (365) Uda rams and forty-nine (49) Uda ewes, one hundred and ninety-nine (199) Balami rams and twenty-five (25) Balami ewes. Data were collected between October 2012 and March, 2013. Body measurements were taken when the animals were in

Table 1: Partial Correlation of Morphometric Traits Uda and Balami Breeds of Sheep

	SW	NC	HeL	HW	HL	HoL	RW	RL	TL	EL	FLL	BL	WH	HG	PG	RH
SW	1															
NC	.532	11														
HeL	.501	.405	1													
HW	.565	.453	.501	1												
HL	.456	.622	.548	.451	1											
HoL	.492	.519	.495	.484	.519	1										
RW	.461	.340	.342	.666	.269	348	1									
RL	.476	.578	.408	.462	.497	.517	.389	1								
TL	.474	.393	.581	.468	.424	.584	.317	.416	1							
EL	.390	.335	.526	.379	.338	.519	.250	.351	.499	1						
FLL	.283	.482	.437	.279	.557	.511	.094[+]	.484	.384	.448	1					
BL	.569	.563	.619	.710	.588	.694	.650	.535	.602	.460	.381	1				
WH	.595	.566	.750	.572	.651	.679	.411	.524	.689	.610	.585	.750	1			
HG	.637	.596	.772	.572	.680	.612	.411	.507	.636	.572	.529	.740	.870	1		
PG	.559	.581	.611	.494	.611	.565	.358	.527	543	.496	.497	.654	.719	.728	1	
RH	.529	.458	.695	.534	.568	.612	.386	.440	.646	.606	.543	.667	.819	.778	.678	1
RLL	.288	.427	.488	.230	.571	.516	.024[+]	.418	.413	.520	.783	.351	.631	.571	.510	.581

(+) Correlations that are not significant (p>0.05)

Table 2: Extraction of the First Two Principal Components For Balami Sheep

Principal component	Eigenvalue	%of variance	Cumulative
1	9.318	54.815	54.815
2	2.056	12.096	66.911

Table 3: Extraction of the First Two Principal Components for Uda Sheep

Principal component	Eigenvalue	%of variance	Cumulative
1	8.173	48.077	48.077
2	1.590	9.351	57.426

Table 4: Loadings of the PCA Extraction with Varimax Rotation for Uda for Balami Sheep

	Uda	Uda	Balami	Balami
Traits	PC1	PC 2	PC1	PC2
BL	0.792	0.365	0.390	0.780
WH	0.801	0.355	0.760	0.570
HG	0.841	0.377	0.723	0.585
PG	0.646	0.428	0.712	0.531
RH	0.769	0.197	0.742	0.553
RW	0.697	0.225	-0.048	0.793
RL	0.098	0.730	0.449	0.583
TL	0.682	0.083	0.457	0.507
EL	0.581	0.212	0.628	0.249
FLL	0.175	0.748	0.865	-0.051
RLL	0.288	0.663	0.905	-0.153
SW	0.495	0.370	0.138	0.780
NC	0.200	0.725	0.511	0.488
HeL	0.824	0.143	0.561	0.488
HW	0.610	0.272	0.845	0.137
HL	0.365	0.665	0.686	0.337
HoL	0.349	0.564	0.521	0.493

Table 5: Index Value and Body Ratio of Uda and Balami Sheep

Index	Uda	Balami
Height slope (cm)	2.27 ± 0.37^{a}	2.43 ± 0.22^{a}
Length Index	0.90 ± 0.01^{b}	0.94 ± 0.01^{a}
Width Slope	0.77 ± 0.01^{c}	0.88 ± 0.02^{a}
Depth Index	0.34 ± 0.01^{a}	0.32 ± 0.01^{ab}
Cephalic Index	1.74 ± 0.01^{a}	1.66 ± 0.01^{c}
Girth Index	1.15 ± 0.01^{ab}	1.16 ± 0.00^{a}
Balance	0.76 ± 0.01^{a}	1.01 ± 0.08^{b}
WH: BL	1.11: 1	1.07: 1
RLL: HoL	1.78: 1	1.79: 1
RLL: FLL	1.15: 1	1.13: 1

standing position with head raised and weight on all four feet without body movement. They were sometimes restrained when they struggle. Measurements were taken with a flexible tape rule. The illustrations for the measurements are described by FAO (2012). Seventeen (17) metric traits were measured on each animal using the identification marks already documented; Rump Width (RW), Rump Length (RL), Tail Length (TL), Wither Height (WH), Heart Girth (HG), Pouch Girth (PG), Rump Height (RH), Ear Length (EL), Foreleg Length (FLL), Rear-leg Length (RLL), Body Length (BL), Shoulder Width (SW), Neck Circumference (NC), Head Length (HeL), Head Width (HW), Horn Length (HL), and Hock Length (HoL). The procedure and anatomical reference points for the respective body measurements are described by Searle *et al.,* (1989); Salako and Ngere (2002).

Data Analysis

Data collected were adjusted for sex and age. Morphology indices were calculated based on Salako (2006) and Alderson (1999) methods, in order to assess the type and function of the two breeds of sheep. Morphology indices were calculated as follow:

1. Height slope = wither height - rump height
2. Length index = body length / wither height
3. Width slope = rump width / shoulder width
4. Depth index = chest depth / wither height
5. Chest depth = wither height – foreleg length
6. Girth index = Paunch girth/ heart girth
7. Cephalic index = Head length/ head width
8. Balance (BALC) = (rump length x rump width) / (chest depth x shoulder width)

Cumulative index was not possible because body weight was not available for use in this study. The ratios that were calculated include WH: BL, BL: SW, RLL: HoL and RLL:FLL

Partial correlation was computed on the morphometric parameters to determine the degree of associations among the linear measurements taking breeds as the controlling variable. This was done to evaluate changing magnitude of associations among the traits. Data were inspected for adequacy in sampling using Kaiser-Meyer-Olkin (KMO) test. Bartlett's test of sphericity test the null hypothesis that the test is an identity matrix and it is expected to be significant before factor analysis can be performed. Data were also inspected for multicollinearity and singularity. Factor analysis was done using the Principal Components Analysis (PCA) extraction method. Principal component analysis is a method for transforming the variables in a multivariate data set, X_1, X_2, X_3,….X_p into new variables, Y_1,Y_2, Y_3…Y_p which are uncorrelated with each other and account for decreasing proportions of the total variance of the original variables defined as:

$Y_1=a_{11}X_1+a_{12}X_2+a_{13}X_3+\ldots+a_{1p}X_p$

$Y_2=a_{21}X_1+a_{22}X_2+a_{23}X_3+\ldots+a_{2p}X_p$

$Y_3=a_{21}X_1+a_{22}X_2+a_{23}X_3+\ldots+a_{2p}X_p$

With the coefficients being chosen; so that Y_1, Y_2, Y_3…Y_p are accounted for decreasing proportions of the total variance of the original variables X_1. X_2. X_3…. X_p Everitt *et al*. (2001); Gaspersz (2007) and Mulyono *et al.,* (2009).

RESULTS AND DISCUSSION

From the result of Partial correlation presented in Table 1, all traits showed a significant correlation less the correlation between RW and both legs. The significant correlation coefficients obtained from this study ranged between 0.250-0.870. These high phenotypic correlations between traits suggest appropriateness of PCA to classify the variables. Predictability of one of these traits with one or some of other traits is also highly probable, thought that goes beyond the scope of this study. Significant correlations of most of these traits have been reported by several workers (Salako, 2006; Mulyono *et al.,* 2009). Salako (2006) even reported correlation of up to 0.99 in a similar study on immature Uda sheep. These relatively large correlation coefficients reported by the author could have resulted from the stage of growth of animals used for that study. When studies are carried out on animals with actively dividing cells (actively growing), there are propensities for high correlation between body measurements, and also auto-correlation is mostly probable when small sample size is considered.Kaiser Meyer-Olkin (KMO) test gave values of 0.923 and 0.932 for Balami and Uda sheep respectively. The KMO values presented were close to 1 which indicated that the sum of partial correlations was small relative to the sum of correlation. Invariably, the patterns of correlation were relatively compact and so PCA analysis should yield distinct and reliable components. Kaiser (1974) recommended the acceptable value of 0.5. So also, the chi-square values for Bartlett's test of sphericity were 2944.49 and 4044.57 for Balami and Uda sheep respectively. Bartlett's measure tests the null hypothesis that the original correlation matrix is an identity matrix. The highly significant chi-square values presented in this study indicated that factor analysis was appropriate. Total variance could be partitioned into shared or common variance, specific variance and error or residual variance. The communality after extraction gives the common variance that is shared between the variables. Communalities after extraction range between 0.441-0.903 for the two genotypic groups, an indication that most of the variances are shared between the variables permitting the use of PCA to classify them.

Rotated component matrix of the PCA extraction is presented in Table 4. This table depicts the loadings of all measurements on the two components extracted for the two breeds of sheep studied. For Uda sheep BL, WH, HG, RH, EW, TL, EL, HeL and HW loaded on the first components while RL, FLL, RLL, NC, HL and HoL loaded on the second components. The first and second components account for 48.08% and 9.35% of the total variance respectively. For Balami sheep, WH, HG, PG, RH, FLL, RLL, NC, HeL, HL and HoL loaded on the first component while BL, RW, RL, TL, SW and HW loaded on the second component.

The first and second components account for 54.82% and 12.10% of the total variance respectively. The candidate traits that loaded in the same component were classified together; therefore pleitropy could be implicated for these traits. Traits that were related to bone development generally had high loadings while traits associated with flesh were relatively low in loadings. This was obvious with the high loadings observed in WH, RLL, FLL and HG for the two genotypic groups under study. Relatively low loadings of NC for both breeds could be associated with the flesh and mane which were highly variable. Measurements that were associated with cranial development (i.e HeL and HW) tend to load on first component for both breed which suggested them as classification traits for these sheep but inclusion of more cephalic measurements will bring to light their suitability for breed classification in sheep. Parés I Casanova *et al* (2012) have used morphometric traits of cephalic region to classify Pyrenian cattle with great success. In a similar study conducted by Salako (2006) on immature Uda sheep, all parameters considered but SW, RL and RW loaded on the first component. The result cannot be accurately compared with this study because face length (FL) was the only cranial measurement considered in that study. The author also suggested the inclusion of more measurements in the PCA model in future study.

Body indexes and ratio are presented in Table 5. These Northern sheep investigated were higher at wither than the rump. Relative balance between the heights at withers and rump in WAD sheep reported by Agaviezor *et al.,* (2012) supports the reasons behind its survivability in the Southern region. Southern region of Nigeria is a region with hills which makes the topography to be steep sloppy. This balance is essential for animals to climb hills and descend valleys effectively, thus, this is an important adaptive feature and it's a criterion to be looked into in developing a suitable breed for the ecological zone since slanted animal may have difficulties in grazing on hilly topography. These height slopes were partly in variance with the report of Yakubu and Ibrahim (2011), though height at wither were reportedly higher than height at rump for both breeds but differences were not as large as those obtained from this study. The proportion of hock to rear leg determines animal posture. The ratios of rear leg to hock lengths were 1.78:1 and1.79:1 for Uda and Balami respectively, thus these sheep had 56.28% and 56.38% of their rear leg as hock. The proportion of hock to rear leg is responsible for the large angle at tibio-femoral joint; this makes the animals to be upright in positioning. The ratio of how long to how tall an animal is determines its stability on motion. This index can be better understood with critical study of phylogenetic trend of component traits since animal that maintain good balance between heights at wither and length of body appears squared and usually have compact body, this enables them to effectively run from predators. An appreciable balance in indices was observed in Balami sheep. Uda sheep looked taller. These length indices were similar to 0.84, 0.95 and 0.99 reported for St.Croix Cross, Sumatra Composite and Garut Composite sheep of Indonesia (Hardiwirawan *et al.,* 2011).

CONCLUSION

With certainty, traits that are associated with bone development especially cranial measurements best describe the two breeds investigated. Thus, incorporating more cephalic measurements in the PCA models combine with biometry (PCA) of cephalic anatomy will shed more light on the suitability of head measurement for breed classification. All characters that loaded in the same component have high correlation with the component to which they were extracted; hence, pleiotropy could be implicated for such traits.

REFERENCES

Agaviezor BO, Peters SO, Adefenwa MA, Yakubu A, Adebambo OA, Ozoje M, Ikeobi CON, Wheto M, AJayi OO, Amusan SA, Ekundayo OJ, Sanni TM, Okpeku M, Onasanya GO, Donato, MD, Ilori BM, Kizilkaya K, Imumorin IG (2012).Morphological and DNA diversity of Nigerian indigenous sheep. *Journal of Animal Science and Biotechnology* 3:38. http://www.jasbsci.com/content/3/1/38.

Anderson S, Centoze R (2007). Property rights and the management of animal genetic resources. Wrld Develop. 35, 1529-1541. breed and performance of sheep in a humid tropical environment. Livestock Research for Rural Development, 23, 2.

Brown CJ, Brown JE, Butts WT (1973).Evaluating relationships among Immature measure of size, shape and performance of beef bulls. II.The relationships between immature measures of size, shape and feedlot traits in young beef bulls. *J. Anim. Sci., 36*:1021.

Carpenter Jr. JA, Fitzhugh HA, Cartwright TC, Melton AA Thomas RC (1971). Principal components for size of Hereford cows. *J. Anim. Sci., 33*:197.

El-Khidir OA (1980). A note on prediction of live weight of growing Kenana heifers from linear body measurements. *Sudan Journal of veterinary Science and Animal Husbandry* 21(2): 102-104.

Everitt BS, Dunn G (1999). Applied Multivariate Data Analysis. Edward Arnold. London.

Gasperzs V (1992). Analysis Technique and experiment reserach. 2nd Editn. Tarsito Publisher. Bandung

Haur Jr. JF, Black WC, Babin JB Anderson RE (2010). Multivariate Data Analysis. Seventh Edition. *Pearson Prentice Hall.* Pp 93-115.

Handiwirawan E, Noor RR, Sumantri C, Subandriyo (2011). The differentiation of sheep breed based on the body measurements. *J.Indonesian Trop.Anim.Agric. 36(1) 1-8.*

Jamssems S, Vandepitte W (2004): Genetic parameters for body measurements and linear type traits in Belgian Blue du Maine, Suffolk and Texel sheep. *Small Ruminant Research.* 54:1-2. Pp 13-24.

Kaiser HF (1974). An index to factorial simplicity. Psychometrika, Vol. 39, issue 1, pp 31-36.

Lawrence TLJ, Fowler VR (1997): Growth of Farm Animals. *CAB International, Wallingford, U.K.*

Mulyono RH, Gunawan A Sumantri C (2009). Characteristics of Size and Shape of Body Dimension of Madura and Rote (Indonesia) Fat-Tailed Sheep Using Principal Component Analysis. *The 1st International Seminar on Animal Industry 2009. Pp253-258.*

Parés I Casanova PM, Sinfreu I Villalba D (2012). Principal component of cephalic morphology to classify Pyrenean catlle. Animal Genetic Resources, Food and Agriculture Organization of the United Nations, doi: 10.1017/S2078633611000385 pp59–64.

Salako AE(2006).Principal component factor analysis of the morphostructure of immature Uda sheep. *Int. J. Morph.* 24: 571-574.

Salako AE, Ngere LO (2002). Application of multifactorial discriminant analysis in the Morphometric structural differentiation of the WAD and Yankasa sheep in the humid southwest Nigeria. *Nig. J. Anim. Prod., 29(2):*163- 7.

Searle TN, McGraham W, Donnelly JR (1989). Change of Skeleton Dimension during Growth in Sheep; The Effect of Nutrition. *Journal of Agric. Science (Cambridge)* 112: 321-327.

Yakubu A, Ibrahim IA (2011). Multivariate analysis of morphostructural characteristics in Nigerian indigenous sheep, Italian Journal of Animal Science, 10, 83-86.