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Morphometric Attributes and Differentiation of Selected Indigenous Cattle Breeds in Nigeria

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Target Audience: *Academic Researchers, Cattle Farmers, Animal Breeders and Geneticists*

Abstract

Population differentiation of farm animals is used for objective choice of parental genotypes that constitutes new hybrids in crossbreeding. In Nigeria, population characteristics of selected indigenous cattle breeds have not been fully documented. Therefore, morphometric attributes of selected indigenous cattle breeds in Nigeria were assessed. Three hundred and one (301) White Fulani (WF), 242 Red Bororo (RB), 247 Sokoto Gudali (SG), 233 Bornu Kuri (BK) and 184 Muturu cattle in the age group of 3 to 3$^{1}/_{2}$ years were purposively sampled from Gombe, Kaduna, Niger and Ogun States. Eighteen (18) morphometric parameters were measured using standard procedures. Data were analysed using descriptive statistics, cluster analysis and Euclidean genetic distance. The EL (cm) for WF (23.86±3.08), SG (24.17±3.82), RB (24.07±3.74) and BK (24.17±3.15) were significantly higher than that of Muturu (14.62±2.01). The Foreleg length (FLL) and tail length (TL) of WF, SG, RB and BK were significantly longer than that of Muturu. Muturu has a significantly shorter TL than WF, SG, RB and BK. The longest genetic distance at the morphometric level was 146 between Muturu and BK and shortest (44) between BK and RB. Differences existed in face length, rear leg length, wither height and rump height of the various breeds of cattle.

Keywords: *Breed differentiation; Genetic distance; Indigenous cattle; Morphometric attributes.*

Description of the Problem

Indigenous cattle breeds are important to us as they are well adapted to local climates, food supply and other local environmental factors, which often shows in their robustness. Indigenous livestock resources are also strategic in the socio-economics of rural agricultural systems to ensure food security in developing countries. The initial step however, in characterization is identification of distinct populations using information on their geographic and ecological isolation, traditional nomenclature (traditionally, recognized populations), phenotypic distinctness and level of genetic differentiation among the population (1). One of the ways of characterizing livestock breeds is to evaluate their morpho-structural characteristics and determine genetic distance among contemporary populations (2). This study is designed to unveil the phenotypic and genetic diversity among the selected Nigeria indigenous cattle breeds using primary data obtained from field morphological survey to assess diversity of the selected indigenous populations in order to update published variations as well as document genetic distances between the populations. This

will help to better understand the genetics of Nigeria breeds of cattle for improvement and conservation goals and unravel the biodiversity that exist among the breeds using morphological analysis. It will also provide a quantitative assessment of the diversity among the selected indigenous cattle breeds in Nigeria and thereafter provides light for objectives prediction and pave way for a better improvement in planning for a productive genetic improvement. It will also help government, department and agencies to maintain good quality breeds of cattle.

Materials and Methods

Animals were sampled from four different isolated areas where they were abundant in Nigeria. The locations were selected because of the availability of the breeds and willingness of the owners to allow the animals for sampling. White Fulani population was sampled from Billiri and Kaltungo (Gombe State), Sokoto Gudali and Bornu Kuri populations were sampled from Funakuna and Bokani (Niger State), Red Bororo population was from Gusau and Birnin Gwari (Kaduna State) and Muturu population from Ipokia (Ogun State). Each location was divided into clusters of ten (10) units for easy measurements and animals that were within the age bracket of 3 to $3^1/_2$ years were sampled. A total of one thousand, two hundred and seven (1207) both sexes of indigenous cattle comprising three hundred and one (301) White Fulani, two hundred and forty seven (247) Sokoto Gudali, two hundred and forty two (242) Red Bororo, two hundred and thirty three (233) Bornu Kuri and one hundred and eighty four (184) Muturu were sampled.

Data Collection

Eighteen (18) linear body measurements (cm) were taken on each sampled animal with the use of measuring tape, these include wither height (WH), body length (BL), shoulder width (SW), rump length (RL), rump width (RW), horn length (HL), head width (HW), shin circumference (SC), ear length (EL), tail length (TL), Face length (FL), Foreleg length (FLL), rump height (RH), heart girth (HG), neck circumference (NC), neck length (NL), hock length (HoL) and rear leg length (RLL). Quantitative variables measured in this study were adapted from the standard cattle descriptor list (3) and a final list of variables were developed and used. Documented morphological features described by (4) were used as base line markers to ascribe sampled animals to a breed. Individuals that do not strictly conform to primary breed characters; visibly pregnant, sick and castrated animals were excluded this is because of the effects these physiological changes would have on their body conformation.

Statistical Analyses

Data collected were subjected to Generalized Linear Model Analysis of variance (GLM) procedure of the Statistical Analysis System (5). Least Square Means ($\bar{X}$) and Standard Error (SE) associated with each linear body measurements were estimated. Genetic distances among the five breeds based on their morphometric variables were calculated using DA Euclidean genetic distance measure.

The statistical model used for analyzing quantitative phenotypic variation among the breed populations is as follows:

$$Y_i = \mu + B_i + e_{ij}$$

Where Y_i = observed value body measurements,

μ = overall mean
B_i = fixed effect of breed (i = 1, 2,..5)
e_{ij} = error

Results and Discussion

Mean values of morphological variables and their standard errors (S.E.) are depicted in Table 1 for aggregated gender. Pairwise mean comparison showed significant differences for most of the morphological variables among the breeds. Morphological variables such as wither height, rump height, body length, and tail length were significantly higher ($p<0.05$) for White Fulani and Sokoto Gudali as compared with the other breeds considered in this study. Muturu breeds were also significantly ($p<0.05$) superior in the measurements of their face length and head width than the quadriad of White Fulani, Sokoto Gudali, Red Bororo and Bornu Kuri. Moreover, Red Bororo and Bornu Kuri were wider at the shoulders than the trio of White Fulani, Sokoto Gudali and Muturu. Similarly, neck circumference of Red Bororo and Bornu Kuri were generally higher than what obtained in White Fulani, Sokoto Gudali and Muturu. The genetic distance among the cattle populations ranged from 43.77 to 145.52 (Table 2). The longest genetic distance was observed between Bornu kuri and Muturu while the shortest distance was observed between Red Bororo and Bornu Kuri. The results indicated that the Bornu Kuri and Muturu were less genetically related (145.52) compare with the other paired breeds and a distance of 114.87 between Muturu and White Fulani. These results indicated that Muturu is less genetically related to Red Bororo and White Fulani when compared with Sokoto Gudali that is with a distance of 54.36 with White Fulani on one hand; and a distance of 65.63 with Red Bororo on the other hand. The cluster analysis generated showed two main clusters having Muturu in a cluster and White Fulani, Sokoto Gudali, Bornu Kuri and Red Bororo in the other. A cluster having the four breeds further branched to form two other clusters having Bornu Kuri and Red Bororo in a branch and White Fulani and Sokoto Gudali in the other.

The significantly higher values for most of the morphometric measurements of White Fulani, Sokoto Gudali, Red Bororo and Bornu Kuri that were predominantly in the northern part of the country than Muturu that is predominantly in southern part of the country seem to be an adaptation where tallness (wither height) and large body size (heart girth and body length) are suitable for trekking long distances to water and grazing points and this is in agreement with what (4) and (6) reported. These observations could be as a result of genetic and species differences. The differences in body measurements of the five cattle breeds with respect to some morphological variables indicate that the five cattle breeds were sub-divided into distinct populations perhaps due to differences in availability of feed resources, breeding practices used and inherent genetic differences (7). The small stature of Muturu might, therefore be an adaptive mechanism to poor availability of feed due to shortage of grazing land caused by high human population pressure and expansion of cropping activities. A shorter genetic distance obtained between White Fulani and Sokoto Gudali suggests a close genetic relationship between the breeds while the longer genetic distance was observed between White Fulani and Muturu is an indication that an appreciable heterosis especially with regard to most

body measurements, which are of economic importance, can be obtained by crossing any of the two breeds. The phylogenetic tree constructed separated the five cattle breeds into two main clusters. The closer genetic relationship between White Fulani and Sokoto Gudali breeds may be attributed to possible interbreeding between these two populations that are predominantly in the northern part of the country forming homogeneous population separated by no physical geographic boundaries. In addition, the close genetic relationship between the breeds may also be attributed to similarity in ecological zones and production systems as well as the incidents of cross border livestock rustling contributing to the migration and movement of livestock and subsequent interbreeding between such livestock, this in agreement with had been reported by (6). There were clear disparities in the wither height and body length of the five breeds. White Fulani was found superior to any of the other four breeds studied. Genetic distance based on morphological indices among the breeds as revealed by the cluster analysis showed that the breeds were genetically distinct.

Conclusion and Applications

1. Morphometric attributes are very good tools in differentiating cattle on the basis breeds, the results obtained in this study may guide in proper identification and selection of cattle breeds.
2. There were clear disparities in the wither height of the five breeds, which showed that White Fulani was found superior to any of the other four breeds studied.
3. There were clear disparities in the body length of the five breeds studied; White Fulani was found to be genetically longer than any of the other four breeds studied.
4. However, future studies should involve a more comparative study using DNA sequencing, Restriction Fragment Length Polymorphism (RFLPs) and Microsatellite markers or Single Tandem Repeats (STRs).

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Table 1: Means of body measurements amongst the five cattle breeds

	WF	SEM	SG	SEM	RB	SEM	BK	SEM	MU	SEM
Face Length (FL)	49.37^{b}	0.44	47.51^{c}	0.36	40.35^{c}	0.33	45.44^{d}	0.57	54.03^{a}	0.39
Head Width (HW)	22.62^{c}	0.16	22.57^{c}	0.15	21.21^{d}	0.14	24.11^{b}	0.18	28.53^{a}	0.68
Horn length (HL)	45.16^{a}	0.84	4.56^{d}	0.44	38.05^{b}	0.32	38.39^{b}	0.57	8.30^{c}	0.35
Ear length (EL)	23.86^{a}	0.52^{a}	24.17^{a}	0.65	24.07^{a}	0.52^{a}	24.17^{a}	0.56	14.61^{b}	0.24
Neck length (NL)	54.56^{a}	0.58	51.34^{b}	0.41	38.97^{c}	0.40	38.79^{c}	0.51	25.40^{d}	1.09
Neck Circumference (NC)	54.71^{c}	0.51	59.08^{b}	0.51	76.85^{a}	0.32	77.75^{a}	0.81	60.93^{b}	0.18
Wither Height (WH)	130.39^{a}	0.21	129.21^{a}	0.23	125.65^{b}	0.11	125.18^{b}	0.15	82.41^{c}	0.07
Foreleg length (FLL)	78.39^{b}	0.45	80.39^{b}	0.45	85.96^{a}	0.41	87.59^{a}	0.43	56.71^{c}	0.25
Hearth Girth (HG)	83.20^{c}	0.18	95.92^{b}	0.28	144.41^{a}	0.12	144.40^{a}	1.12	57.03^{d}	0.43
Body length (BL)	116.45^{a}	0.11	116.03^{a}	0.08	111.17^{b}	0.06	112.64^{b}	0.41	73.55^{c}	0.21
Rump Height (RH)	135.40^{a}	0.17	134.22^{a}	0.21	130.59^{b}	0.09	131.53^{b}	0.50	88.46^{c}	0.54
Rump Length (RL)	30.56^{a}	1.19	30.58^{a}	0.26	31.03^{a}	0.75	30.97^{a}	0.21	20.89^{b}	0.41
Rearleg Length (RLL)	105.45^{a}	0.21	105.41^{a}	1.01	104.64^{a}	0.19	105.06^{a}	1.17	73.93^{b}	0.63
Tail length (TL)	96.10^{a}	0.49	94.98^{a}	0.36	91.89^{b}	0.17	91.30^{b}	0.14	55.98^{c}	0.41
Shin Circumference (SC)	25.06^{a}	0.43	2475^{ab}	0.39	24.66^{ab}	0.22	24.40^{b}	0.08	21.86^{c}	0.14
Hock length (HoL)	50.90^{a}	1.11	50.05^{b}	0.71	50.07^{b}	0.47	49.41^{b}	0.43	32.74^{c}	0.35
Rump Width (RW)	35.19^{a}	0.56	35.38^{a}	0.42	34.45^{b}	0.41	35.18^{a}	0.20	28.32^{c}	0.24
Shoulder width (SW)	68.02^{b}	0.52	69.59^{b}	0.34	80.89^{a}	0.46	81.85^{a}	0.11	63.58^{c}	0.22

Means with same superscript are not significantly different (P>0.05).
WF =White Fulani, SG = Sokoto Gudali, RB = Red Bororo, BK = Bornu Kuri, MU = Muturu

Table 2: Euclidean genetic distance estimate based on morphometric variables

Breed / Breed	White Fulani	Sokoto Gudali	Red Bororo	Bornu Kuri	Muturu
White Fulani	**				
Sokoto Gudali	54.36	**			
Red Bororo	70.44	65.63	**		
Bornu Kuri	54.54	76.54	43.77	**	
Muturu	114.87	83.86	136	145.52	**

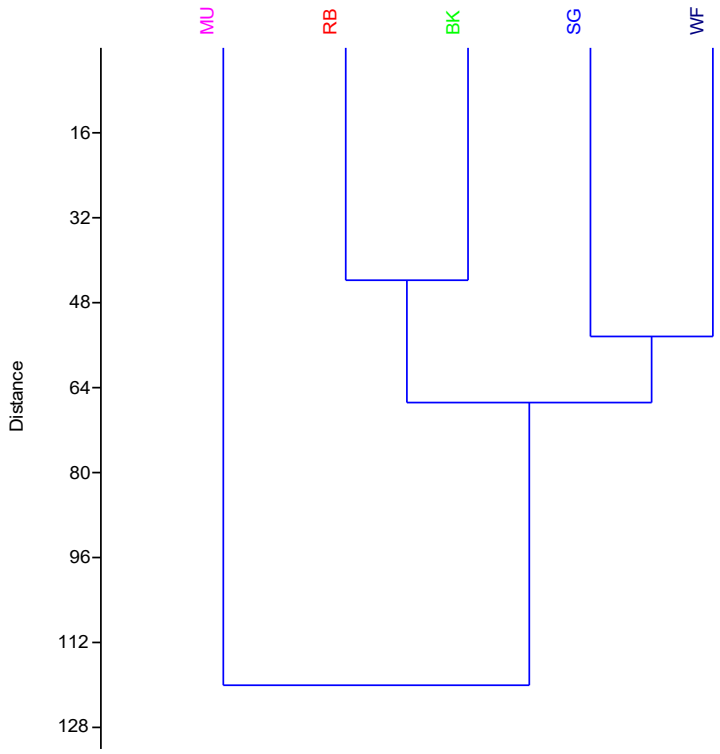

Fig. 1: Dendrogram showing genetic relationship among White Fulani (WF), Sokoto Gudali
(SG), Red Bororo (RB), Bornu Kuri (BK) and Muturu (MU) breeds of cattle based on morphometric variables.