



Application of Discriminant Analysis on the Forest Muturu Cattle in Different Locations in Southern Zone of Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

About 238 mature Forest Muturu cattle were sampled from Southern Nigeria (Enugu, Imo, Delta, Anambra and Ebonyi) States. Discriminant analysis was performed on the effects of location using body weight and body linear parameters. Horn length was the only parameter selected for stepwise discriminant analysis to separate the populations of forest Muturu bulls. Horn length, muzzle circumference, body length, chest girth and ear length were the selected parameters by stepwise discriminant analysis to separate the forest Muturu cows populations. The strength of the canonical correlation model to explain the variations between the groups 0.615, 0.450, 0.364 and 0.335 for functions 1, 2, 3 and 4 respectively among cows and 0.71, 0.59, 0.50 and 0.29 for functions 1, 2, 3 and 4 respectively among bulls. Location was found to influence body parameters. There is need to carry out further study to assess performance characterization of the Forest Muturu cattle in Nigeria to identify the superior genetic grades base on economic traits which may be useful in establishing nucleus breeding center.

Keywords: Muturu; cows; bulls; morphometric traits; discriminant analysis.

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1. INTRODUCTION

1.1 Background of Study

Characterization of local genetic resources assesses variation of morphological traits [1]. The variation of morphological traits has played a fundamental role in the classification of livestock based on size and shape [2]. Morphological characteristics can be grouped into discrete traits (qualitative characters) and continuous traits (quantitative characters) that can be used to assess genetic variation and phylogenetic relationships between various populations [3]. In animal breeding, the quantitative traits are the major traits of economic interest; they show continuous variation [4].

Body measurements and body weight give thorough description of individual or population of animals [5]. Body dimensions have been used to indicate breed, origin and relationship between individuals or populations [6]. Morphometric measurements of body conformations were reported to be vital in judging quantitative traits useful for developing suitable selection criteria and breed characterization [7,8]. Hence, morphological measurements of the forest Muturu could be used for breed characterization and selection decision [9].

The forest Muturu is among cattle breed reported to be under extinction threat due to effect of small population and uncontrolled breeding. Indiscriminate crossbreeding may lead to erosion and complete masking of important traits, such as disease resistance and adaptation [10]. The use of discriminant analysis between the forest Muturu populations will play a major role in identifying variation between populations and the maintenance of these genetic resources.

1.2 Literature Review

According to Yahaya (2018) the Forest Muturu is smaller than the Savannah Muturu. The breed stand 85 to 90 cm at withers. The head is less bulky and longer, with a conspicuous poll and protruding eyes. The horns are very imperfect, often thin or flat and sometimes loose or absent. The line of the back slopes down from rump to withers more steeply (3 to 5 cm) than in the Savannah Muturu. According to Roger (1999) the coats tend to be pure black in the forest Muturu.

In an experiment to ascertain the body linear traits selected in a discriminant analysis N'Goran et al. [11] noted that out of fifteen evaluated body

linear traits, nine were (head length, head width, skull width, muzzle length, chest length, height at withers, chest depth and body length) selected as the most discriminant variables. On dairy cattle, body length, chest length and muzzle length were observed to be statistically reliable to account for location in central and south regions in Cote d'Ivoire [11]. On the other hand, Sakouri et al. [12] observed that notably, chest depth and height at withers were the body linear variable selected to account for location effect using discriminant analysis in two (2) locations.

According to Pundir et al. [13] stepwise discriminant analysis showed that height at wither, body length, ear length, tail length, paunch girth and face were the most discriminating variables between these three cattle populations in North East India. Studies, Yakubu et al. [2] reported that height at wither and face length most discriminating traits in two distinct cattle breeds.

2. MATERIALS AND METHODS

2.1 Study Locations

The study was carried out in selected communities in one agro-ecological zone, (the Forest zone) of in the southern part of Nigeria. The locations covers: Enugu (6° 27' 35.87"N and 7° 32' 56.22" E), Imo (4° 45'N and 7° 15'N; 6° 50'E and 7° 25'E), Delta (5° 00'N and 6° 30'; 5° 00 and 6° 45'), Anambra (6° 20'N and 6.33° N; 7° 00'E and 7.000° E) and Ebonyi (6° 15'and 6.25°; 8° 05'and 8.083° E) as presented in Figure. Nigeria has two distinct seasons the wet season which last from April to October and dry season which last from November to March. The annual rainfall ranges from 1000 to 4000mm. Temperature ranges from 6°C to 52°C (Google Maps, 2016).

2.1.1 Experimental animals and their management

The study was carried out on forest Muturu cattle owned and raised by rural forest Muturu farmers under semi intensive management system. Group housings were provided to the experimental animals with fenced, unroofed and roofed yards.

2.1.2 Sampling technique and data collection

About 238 forest Muturu cattle of different ages and sexes were measured from the forest

Muturu cattle owners and farms from the forest zone of southern Nigeria.

2.2 Parameters Measured

The traits measured were body Length, Height at withers, Chest Girth, Horn Length, Tail Length, Muzzle Circumference, Ear Length, Hock Circumference, Pelvic Width, Cannon Bone Circumference, Body Weight and Facial Length with the aid of a flexible tape using the procedure described by Adembabo (2001).

2.3 Data Analysis

Data collected were subjected to statistical analysis: Analysis of variance (ANOVA) and Discriminant analysis) using the SPSS version 21. Means and estimates of their standard errors and NRDCN test were carried out between different populations. Multi traits linear model was used to analyze for the effect of factors measured in the different populations:

$$Y_{ijkl} = \mu + A_i + B_j + \varepsilon_{ijk}$$

Where;

Y_{ijkl} = individual observation on the body traits;
 μ = overall mean;
 A_i = fixed effect of i^{th} sex ($i = 1, 2$);
 B_j = fixed effect of j^{th} location ($j = 1, 2, 3, 4$ and above);
 ε_{ijk} = random error associated with each record ($\varepsilon \sim N(0, \sigma^2)$)

3. RESULTS AND DISCUSSIONS

Table 1 presents the descriptive statistics of body weight and body parameters of forest muturu cows and bulls due to locations. The body weight and body linear traits the Forest Muturu cattle from this study were closer in range to earlier finding by Daikwu et al.(2018) and Oloruntobi [14] respectively. Body weight values in this study were lower than the range value reported by Adebambo(2001).

From Table 2 Bartlett's test chi-squared were significant for functions 1, 2, 3 and 4 among cows while functions 1, 2 and 3 were significant for the bull populations. These were the validity for the canonical discriminant analysis carried out. This agreed with the findings by Daikwo et al. [15] who reported values of 60 and 24 for the Bartlett's test chi-square for functions 1 and 2 respectively. Discriminant analysis shows that

Functions 1, 2, 3 and 4 had Eigen values less than unity. Discriminant analysis due to location of cows and the bulls in Imo, Enugu, Ebonyi, Delta and Anambra locations was gave rise to four discriminant functions. Functions 1, 2 and 3 had Eigen values above unity. Function 4 had Eigen value below unity. Eigen values were high in functions 1 and keep dropping down in functions 2, 3 and 4. These give the reflection of the strengths of this function to discriminate between populations were higher in functions 1 and continue to decrease down functions 3 and 4 among bulls and cows respectively. This trends were similar to report by Yakubu et al. [2]. The strength of the canonical correlation model to explain the variations between the groups were 0.71, 0.59, 0.50 and 0.29 for functions 1, 2, 3 and 4 respectively among bull. Canonical correlations among cows were 0.61, 0.254, 0.153 and 0.126 in functions 1, 2, 3 and 4 respectively.

In Table 3, total sample standardized canonical coefficient and total variance explained by each canonical variable among cows shows that first canonical function (Can1.) explained 53.3 % of the total variation while canonical function two (Can2) explained 33.3 % of the total variation while CAN3 and CAN4 had accounted for 13.3 % and 11.1% of the total variations respectively. Among bulls the first canonical function (Can1.) or fisher linear discriminant function explained 50.6% of the total variation while canonical function two (Can2) explained 27.5% of the total variation while 17.2% and 4.7% for CAN 3 and CAN 4 respectively. Generally the standardized canonical coefficients identify that are up to 0.3 are said to contribute to the discriminate analysis. This finding is agrees with Pundir et al. [13] who informed that body traits have contributed to discriminate between populations.

Table 4 showed that ear length, body length, chest girth, horn length, tail length, muzzle circumference and cannon bone circumference were selected among cows. On the other hand horn length was the only body trait selected in a single step to establish difference between locations in the discriminant equations that accounted for location effect among bulls as shown in Table 5. This result collaborates with the finding of N'Goran et al. [11] and Sakouri et al.[12] who reported that body length and height at withers were the selected morphometric traits that discriminated between locations among dairy cattle. The finding in this study is comparable to N'Goran [11] who reported that among fifteen morphometric traits that were used

to discriminate between populations of cattle, muzzle length, chest length, height at withers and body length were the most discriminating variables.

The classification results of the forest muturu cattle is presented in Table 6 among the cows populations, 83.3, 43.2, 68.6, 50.0 and 42.9 percent cases were correctly classified. Among

the bulls populations, 75.0, 76.2, 75.8, 62.5 and 33.3 percent cases were correctly classified according to location (Table 7). The classification results were lower than 100% in this study and this may implies a possibilities of share gene by decent among the populations giving rise to the misclassification of individuals in a populations into another. Percent classification in this study were closer to the finding of Yakubu et al. [2].

Table 1. Group statistics on body linear parameters of cows and bulls of Muturu cattle populations according to location

Group	Variable	Cows			Bulls		
		Mean	SEM	COV	Mean	SEM	COV
1	EL	15.77	1.21	9.32	15.05	1.16	8.91
	BL	97.15	3.97	16.20	77.80	3.31	14.04
	CG	111.75	3.92	13.78	99.63	3.81	14.54
	HL	9.78	2.02	6.88	6.55	2.61	13.86
	TL	68.15	2.81	11.55	62.00	2.73	12.28
	MC	18.98	1.49	11.71	17.65	0.92	4.84
	HW	80.53	3.10	11.94	78.88	3.00	11.32
	HC	17.68	1.77	17.73	15.50	0.76	3.72
	PW	35.96	1.18	3.86	35.50	1.14	3.64
	CC	14.54	1.17	9.42	13.83	0.55	2.16
2	FL	36.70	1.49	6.01	35.58	1.01	2.87
	BW	133.57	4.40	14.47	137.50	2.61	4.95
	EL	16.30	1.04	6.53	16.019	1.14	8.12
	BL	91.58	2.29	12.28	89.65	2.81	8.81
	CG	110.68	3.18	9.65	106.24	3.29	14.54
	HL	10.10	1.95	7.84	10.86	2.35	15.81
	TL	68.69	2.15	6.93	67.11	2.06	6.32
	MC	20.89	1.36	8.53	20.35	1.35	8.89
	HW	85.50	2.47	7.44	83.69	2.59	8.00
	HC	16.87	1.40	11.07	16.50	1.16	8.17
3	PW	37.50	1.51	6.18	36.91	1.85	9.32
	CC	14.16	1.08	7.78	13.73	0.93	6.36
	FL	37.35	1.57	6.40	36.44	1.68	7.74
	BW	141.62	4.01	11.14	140.48	3.03	6.54
	EL	15.43	1.24	11.17	14.46	1.20	10.01
	BL	88.65	2.77	8.90	85.02	2.58	7.82
	CG	112.78	3.32	9.94	104.48	2.93	8.21
	HL	8.623	1.82	7.22	6.85	1.51	13.20
	TL	67.22	2.49	9.45	65.28	2.45	9.21
	MC	20.73	1.51	11.40	19.83	1.25	7.07
4	HW	85.38	2.66	8.24	81.87	2.43	7.89
	HC	16.61	1.58	14.93	15.48	1.04	7.23
	PW	36.93	1.72	7.99	35.75	1.42	5.68
	CC	13.66	1.14	9.45	13.13	1.06	8.58
	FL	37.00	1.78	8.68	35.10	1.30	4.85
	BW	139.56	4.14	12.82	133.37	3.45	8.92
	EL	16.15	1.42	14.88	15.16	1.41	13.07
	BL	92.17	2.56	11.24	87.29	2.12	5.17
	CG	118.15	3.16	12.02	113.16	3.51	10.90
	HL	12.62	2.18	12.16	11.80	2.11	13.00
	TL	70.46	2.39	8.98	67.51	2.48	9.11
	MC	21.63	1.64	12.67	19.91	1.88	12.74

Group	Variable	Cows			Bulls		
		Mean	SEM	COV	Mean	SEM	COV
5	HW	88.45	1.93	9.51	87.15	2.15	5.31
	HC	17.39	1.36	11.19	16.55	1.10	7.29
	PW	38.05	1.75	8.62	36.60	1.57	6.77
	CC	14.35	1.06	9.45	13.46	1.03	7.96
	FL	38.66	1.98	10.96	36.24	1.12	3.46
	BW	142.66	3.37	12.48	133.45	2.99	6.69
	EL	16.19	1.03	6.54	15.27	1.05	7.22
	BL	87.66	2.93	9.79	80.73	1.54	2.93
	CG	109.46	3.45	10.89	100.67	2.47	6.07
	HL	11.56	1.82	8.71	8.73	1.13	14.54
	TL	66.14	2.16	7.06	62.80	2.16	7.43
	MC	18.93	1.29	8.81	19.10	0.97	4.99
	HW	83.24	2.52	7.61	76.90	2.78	10.02
	HC	15.69	0.88	4.90	15.87	1.03	6.68
	PW	36.37	1.20	3.92	35.67	1.24	4.28
	CC	12.26	1.96	7.33	13.53	0.81	4.75
FL	36.70	1.60	7.02	35.37	0.74	1.56	
BW	141.37	2.86	5.77	123.67	2.73	7.18	

SD= standard deviation, EL= ear length, BL= body length, CG=chest girth, HL=horn length, TL= tail length, MC=muzzle circumference, HW=height at withers, HC=hock circumference, PW=pelvic width, CC=cannon borne circumference, FL= facial length. Where; 1, 2, 3, 4 and 5 = locations. 1=Imo, 2=Enugu, 3=Ebonyi, 4= Delta, 5=Anambra

Table 2. Summary of canonical discriminant function to separate Muturu cattle population into groups according to location

Category	Function	Eigen value	Variance proportion	Canonical correlation	Λ	X^2	Sig
Cows	1	0.610	53.3	0.615	0.381	152.74**	0.00
	2	0.254	22.3	0.450	0.614	77.29**	0.00
	3	0.153	13.3	0.364	0.770	41.35**	0.00
	4	0.126	11.1	0.335	0.888	18.86*	0.03
Bulls	1	0.991	50.6	0.71	0.223	89.20**	0.00
	2	0.540	27.5	0.59	0.445	48.22*	0.04
	3	0.337	17.2	0.50	0.685	22.54*	0.31
	4	0.093	4.7	0.29	0.915	5.27 ^{ns}	0.81

Λ = Wilk Lambda, X^2 = Chi square, *- Significant at $p < 0.05$, **- Significant at $p < 0.01$

Table 3. Standardized canonical coefficient and total variations explained by the canonical functions among cow and bulls populations

Variable	Cows				Bulls			
	CAN 1	CAN 2	CAN 3	CAN 4	CAN 1	CAN 2	CAN 3	CAN 4
EL	-.526	.332	1.036	-.331	-1.019	.249	.333	-.286
BL	.138	-.717	-.116	.013	.671	.537	.837	.074
CG	-.166	.088	.333	.191	.854	-.165	-.593	-.025
HL	-.080	-.655	.048	.012	-.592	.411	-.100	-.313
TL	.839	-.366	.070	-.196	.465	.066	-.431	-.189
MC	-.246	.602	-.022	.869	1.224	.017	.382	-.512
HW	-.118	.748	-.257	-.809	-.311	.455	-.592	.839
HC	-.548	.160	.773	.684	-.117	.954	-.342	.044
PW	.574	.469	.809	.224	.121	-.622	.319	-.262
CC	.479	-.843	-1.195	.292	-.361	-.818	-.421	.049
FL	.033	1.045	-.775	-.523	-.629	-.056	-.232	.187
BW	.187	-.634	.057	-.139	-.149	-.195	.924	.707
Total Variance	53.3	33.3	13.3	11.1	50.6	27.5	17.2	4.7

CAN =Canonical functions 1-4; EL= ear length, BL= body length, CG=chest girth, HL=horn length, TL= tail length, MC=muzzle circumference, HW=height at withers, HC=hock circumference, PW=pelvic width, CC=cannon borne circumference, FL= facial length and BW= body weight

Table 4. Morphological variable selected by stepwise discriminant analysis to separate the populations of forest Muturu into groups among cows

Step	Variable selected	Tolerance	F to remove	Wilks' Lambda
1	Horn Length	1.000	6.627	
2	Horn Length	.602	9.667	.902**
	Muzzle Circumference	.602	7.346	.860**
3	Horn Length	.555	8.245	.760**
	Muzzle Circumference	.511	10.041	.788**
	Body Length	.590	6.212	.728**
4	Horn Length	.543	8.173	.644**
	Muzzle Circumference	.506	8.230	.645**
	Body Length	.325	12.220	.698**
	Chest Girth	.343	7.162	.631**
5	Horn Length	.537	8.655	.585**
	Muzzle Circumference	.493	8.816	.587**
	Body Length	.324	11.292	.617**
	Chest Girth	.310	9.295	.593**
	Ear Length	.665	4.501	.535**

Table 5. Morphological variable selected by stepwise discriminant analysis to separate the populations of forest Muturu into groups among bulls

Step	Variable selected	Tolerance	Statistic	F to remove	Wilks' Lambda
1	Horn length	1.00	0.535	4.634	0.120*

Table 6. Classification result of forest Muturu cows populations according to locations

	Group	1	2	3	4	5	Total
Original count	1	10	1	0	0	1	12
	2	6	19	8	10	1	44
	3	4	10	48	8	0	70
	4	1	6	8	18	3	36
	5	1	1	1	1	3	7
Percent count	1	83.3	8.3	.0	.0	8.3	100.0
	2	13.6	43.2	18.2	22.7	2.3	100.0
	3	5.7	14.3	68.6	11.4	.0	100.0
	4	2.8	16.7	22.2	50.0	8.3	100.0
	5	14.3	14.3	14.3	14.3	42.9	100.0

83.3, 43.2, 68.6, 50.0 and 42.9 percent cases were correctly classified; Where; 1, 2, 3, 4 and 5 = locations. 1=Imo, 2=Enugu, 3=Ebonyi, 4= Delta, 5=Anambra

Table 7. Classification result of forest Muturu bulls populations according to locations

	Group	1	2	3	4	5	Total
Original count	1	3	0	0	1	0	4
	2	0	16	2	2	1	21
	3	0	5	25	1	2	33
	4	0	2	0	5	1	8
	5	1	1	0	0	1	3
Percent count	1	75.0	0	0	25.0	0	100.0
	2	0	76.2	9.5	9.5	4.8	100.0
	3	0	15.2	75.8	3.0	6.1	100.0
	4	0	25.0	0	62.5	12.5	100.0
	5	33.3	33.3	0	0	33.3	100.0

75.0, 76.2, 75.8, 62.5 and 33.3 percent of groups were correctly classified; Where; 1, 2, 3, 4 and 5 = locations. 1=Imo, 2=Enugu, 3=Ebonyi, 4= Delta, 5=Anambra

4. CONCLUSION

The result of discriminant analysis shows that the Forest Muturu cattle differ due to location between populations. Horn length was the major parameter that establishes disparity between the bulls populations in the five study locations. Among cows horn length, muzzle circumference, body length and chest girth were the selected parameters that discriminate between populations. About more than fifty percent of animals in each population were correctly classified into their respective populations. There is need to conduct further study at the molecular level so as to identify superior genetic grade of the Forest in order to apply selection. Interested breeders and farmers can obtain the Forest Muturu cattle from these locations. Government and private firms should open nucleus breeding centers in order to multiply the population of the Forest Muturu cattle.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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