NSAP 47th Annual Conference (JOS 2022) CONFERENCE PROCEEDINGS
THEME: SECURING ANIMAL AGRICULTURE AMIDST GLOBAL CHALLENGES

CLASSIFICATION OF COAT COLOUR PATTERN AMONG SOME CATTLE BREEDS IN NIGERIA USING STEPWISE DISCRIMINANT ANALYSIS

[*1]John, P.A., [1]Kabir, M., [2]Iyiola-Tunji, A.O. and [1]Adedibu, I.I.
[1]Department of Animal Science, Ahmadu Bello University, Zaria, Nigeria
[2]National Agricultural Extension and Research Liaison Services, Ahmadu Bello University, Zaria, Nigeria
*Corresponding author: johnpaulapagu@gmail.com+2348136566374

ABSTRACT
Study was carried out to determine the distributions of coat colour patterns among Adamawa Gudali, Sokoto Gudali, Bunaji and Rahaji cattle breeds using stepwise discriminant analysis. A multistage approach was used to select the cattle from 4 states with large population of agro-pastoralists who rear these breeds. The four States selected were Adamawa, Taraba, Gombe and Sokoto with 4, 4, 3 and 2 Local Government Areas respectively. Snowball method was used to sample 1008 cattle consisting of 162 Adamawa Gudali, 306 Sokoto Gudali, 234 Bunaji and 306 Rahaji cattle from agro-pastoralists in many communities of the LGAs. Stepwise discriminant (STEPDISC) analysis was employed to identify variables for their relative importance in discriminating between groups. The distribution of the measured qualitative traits of cattle was assessed for significance using Chi-square analysis. Results revealed that 72.92% of the coat colour patterns were classified as patched, 55.69% as solid) and 83.33% as spotted. Significant (p<0.001) canonical functions was observed for patched and spotted coat colour patterns. Patched coat colour pattern (0.7725) in the first function and spotted coat colour pattern (0.7676) in the second function had the best and high discriminating power compared to solid coat colour pattern. Patched and spotted coat colour revealed the best canonical discriminant functions, which had high discriminating power in classifying the coat colour patterns into genetic groups.

Keywords: Coat colour pattern, discriminant analysis, breeds, cattle and Nigeria

INTRODUCTION
Coat colour has been used to identify cattle types by farmers and has been associated with predation and thermal regulation selection pressure (Finch *et al*., 1984) with dark coated animals absorbing more heat from solar radiation than light coated contemporaries (Seo *et al*., 2007; Desta *et al*., 2011). The morphological differences within and between livestock populations are attributable to the genetic makeup of individuals and environmental conditions which they exist (Rege and Tawah, 1999). This implies that performance of different breeds will vary in different environment (Pilling *et al*., 2010). Cattle are of special importance because they supply about 50 and 95% of the world meat and milk respectively. In Africa, there are different breeds which represent a rich source of genetic diversity that has not been well studied and exploited. This is reflected in differences in morphology, physiology and behavioral attributes between individuals, breeds and populations (Frankham *et al*., 2002). The differences can be captured through qualitative observation (phenotypic characterization) which are then related to suitability of the selected individuals to perform in the specified environment. Discriminant analysis is a multi-variate tool, which were able to discriminate the appropriateness of coat colour pattern of cattle into genetic groups. This study is aimed at classifying coat colour pattern among cattle using stepwise discriminant analysis.

MATERIALS AND METHODS
Sampling sites and data collection
A multistage approach was used to select the breeds of cattle from the States with large population of agro-pastoralists that rear Adamawa Gudali, Sokoto Gudali Bunaji and Rahaji cattle breeds. Four

States were selected for the purpose of this study with. 4, 4, 3 and 2 Local Government Areas (LGA) from Adamawa, Taraba Gombe and Sokoto states respectively. Selected LGAs included Mubi North, Song, Yola North, Lamurde, Zing, Lau, Ardokola, Yorro, Balanga, Akko, Shongom, Illela and Wurno. Snowball method was used to sample 1008 cattle consisting of 162 Adamawa Gudali, 306 Sokoto Gudali, 234 Bunaji and 306 Rahaji cattle from agro-pastoralists in many communities of the LGAs. Qualitative traits of cattle were classified as patched, solid and spotted coat colour patterns. Coat colour pattern observed on each animal was adapted according to the method of RIM, 1992 and John *et al*. (2017).

Statistical analysis

Discriminant analysis was used on qualitative variables to classify the sample populations into homogenous group on the basis of the observed variables (SAS, 2004). The stepwise discriminant (STEPDISC) analysis was employed to identify variables for their relative importance in discriminating between groups (SAS, 2004). The distribution of the measured qualitative traits was assessed for significance using Chi-square analysis and computed based on pooled data within breed and sex using the Frequency procedure of R 2.13.0 (R Development Core Team, 2015) statistical package.

RESULTS AND DISCUSSION

The re-substitution classification summary of coat colour pattern of cattle are presented in table 1. Discriminant analysis showed that 175(72.92%) of the coat colour patterns were classified as patched. The coat colour patterns that were classified as solid coat colour was 40(55.69%) whereas the spotted coat colour had 40(83.33%). Patched and spotted coat colour patterns revealed high discriminating power in classifying coat colour patterns into genetic groups than solid coat colour pattern. This might be as a result of multi-colour differences observed in patched and spotted coat colour patterns of cattle observed in the studied population. The morphological differences within and between livestock populations are attributable to the genetic makeup of individuals and environmental conditions which they exist (Rege and Tawah, 1999). Similar to the present study, patched colour pattern in Barka cattle breed was dominated by mixed coloured cattle at (39.5%), followed by closely by individuals coloured black at (34%) (Goltom *et al*., 2019).

Table 1. Showed re-substitution classification summary of coat colour pattern of cattle

	Classified			
Coat colour pattern	**1**	**2**	**3**	**Total**
Patched	175(72.92)	64(26.67)	1(0.42)	240(100.00)
Solid	209(29.03)	40(55.69)	110(15.28)	720(100.00)
Spotted	1(2.08)	7(14.58)	40(83.33)	48(100.00)
Total	385(38.19)	472(46.83)	151(14.98)	1,008(100.00)
Priors	0.3333	0.3333	0.3333	

The re-substitution classified and unclassified summary of coat colour pattern of cattle are shown in table 2. Discriminant analysis revealed that 206(85.83%) of the coat colour patterns were classified as patched. The coat colour patterns that were classified as solid coat colour was 352(48.89%) whereas the spotted coat colour had 39(81.25%). The patched (0.00%) and spotted 0(0.00%) coat colour patterns had homogeneous degree of unclassified variables compared to solid coat colour pattern. This shows that the two coat colour patterns were unclassified into genetic groups. The variation in the coat colour type variants observed in the study is similar to the report of Anya *et al*. (2018) who reported that the variation in phenotypic traits of three coat colour (white, brown and mixed colours) cattle might be unconnected with individual breed's potential and peculiarity.

Table 2. Showed re-substitution classified and unclassified summary of coat colour pattern of cattle

	Classified			Unclassified	
Coat colour pattern	**1**	**2**	**3**		**Total**
Patched	206(85.83)	34(14.17)	0(0.00)	0(0.00)	240(100.00)
Solid	286(39.72)	352(48)	80(11.11)	2(0.28)	720(100.00)
Spotted	1(2.08)	8(16.67)	39(81.25)	0(0.00)	48(100.00)
Total	493(49.91)	394(39.09)	119(11.81)	2(0.20)	1,008(100.00)
Priors	0.3333	0.3333	0.3333		

The frequency distribution of coat colour pattern of cattle are shown in table 3. Significant ($p<0.01$) differences were observed among coat colour patterns of cattle observed. The coat colour pattern of cattle observed was mostly solid 720(71.43%), followed by patched colour pattern 240(23.81%) whereas the least was observed in spotted coat colour pattern 48(4.76%). The high frequency of occurrence of solid coat colour pattern observed in this study is similar to the findings of John *et al*. (2017) who reported the highest frequency of occurrence of solid coat colour pattern in donkeys compared to other coat colour patterns.

Table 3. Showed frequency distribution of coat colour pattern of cattle

Coat colour pattern	**Frequency**	**Percent**	**Cumulative frequency**	**Cumulative percent**	**Chi-Square**	**P-value**
Patched	240	23.81	240	23.81	710.29	0.0001
Solid	720	71.43	960	95.24		
Spotted	48	4.76	1008	100.00		

The discriminant functions of coat colour pattern of cattle are presented in table 4. Significant ($p<0.001$) canonical functions was observed for patched and spotted coat colour patterns. Patched coat colour pattern had the highest discriminating variable in the first function (0.7725) whereas the second function (0.7676) revealed spotted coat colour pattern as the best and only variable that had the highest discriminating power compared to other coat colour patterns in the second canonical function. Negative to non-significant ($p>0.05$) canonical functions among other coat colour patterns was observed. Anya *et al*. (2018) reported that the second function does not contribute significantly in the discrimination process as compared to that of the first function. This is in line with the result of this study where the highest discriminant variable was recorded in the first function.

Table 4. Showed Discriminant functions of coat colour pattern of cattle

Coat colour pattern	**Function 1**	**Function 2**
Patched	0.7725	0.3707
Solid	-0.1084	-0.1747
Spotted	-2.2358	0.7676

CONCLUSION AND RECOMMENDATIONS

The patched (72.92%) and spotted (83.33%) coat colour pattern had high discriminating variables in classifying the coat colour patterns into genetic groups compared to solid (55.69%) coat colour pattern.Solid coat colour (720) had the highest frequency of occurrence compared to other coat colour patterns in the population studied. Patched and spotted coat colour patterns should be exploited in classifying the coat colour pattern of cattle into genetic groups because of their high discriminating power.

REFERENCES

Anya, M.I., Okon, B., Dauda, A., Ayuk, A.A. and Chukwumati, M.G. (2018). Phenotypic Characterization of Cattle Based on Coat Colour in Obudu Grass Plateau, South-South Nigeria. A Discriminant Approach. *Nigerian Journal of Animal science*, 20(3): 1-9.

Desta, T., Ayalew, W. and Hedge, B. (2011). Breed and Traits Preferences of Sheko Cattle Keepers in Southern Ethiopia. *Tropical Animal Health Production*, 43: 851-856.

Finch, V.A., Benneth, L.L. and Holmes, C.R. (1984). Coat Colour in Cattle: Effect of Thermal Balance, Behaviour and Growth, and relationship with Coat Type. *Journal of Agricultural Science*, 102: 141-147.

Frankham, R; Ballou, J.D, Briscoe, D.A. (2002). Introduction to Conservative Genetics. Cambridge University Press Retrieved on 20th March, 2018; from: http://www.google.com.

Goltom, S., Gicheha, M.G., Ngeno, K and Njonge, F.K. (2019). Morphological Characterization of Indigenous Cattle breeds in Eritrea. *Advanced Animal Veterinary Science*, 7(10): 848-857.

John, P.A., Iyiola-Tunji, A.O., Akpa, G.N., Iriso, B.V., Millam, J.J. and Mallam, I. (2017). Distributions of Qualitative Traits among Weaner, Young and Adult donkeys in Northwest Nigeria. *Journal of Animal Production Research*, 29 (2): 231-237.

Pilling, D. (2010). Threats to animal genetics resources for food and agriculture: approproaches to recording, description, classification and analysis. *Animal Genetic Resources*, 47: 11-22.

R Development Core Team. (2015). *A Language and Environment for Statistical Computing. R Foundation For Statistical Computing*, Vienna, Austria.URL http://www. R-Project.org/.

Rege, J.E.O. and Tawah, C.L. (1999). The State of African Cattle Genetic Resources II. Geographical Distribution Characteristics and uses of Present-day Breeds and Strains. *Animal Genetic Resources Information*, 26: 1-25.

RIM, (1992). Resources Inventory Management Ltd. Nigeria National Livestock Survey, Federal Department of Livestock and Pest Control Services, Abuja. 287pp

SAS (Statistical Analysis System). (2004). *SAS/STAT user's guide version 9.1*, Cary, NC: SAS Institute Inc.

Seo, K., Mohanty, R.T., Choi, T. and Hwang, I. (2007). Bilogy of Epidermal and Hair Pigmentation in Cattle: A Mini Review. *Veterinary Dermatology*, 18: 392-400.