



Preliminary Investigation of Haemoglobin Polymorphism among Indigenous Cattle in North Western Nigeria

**Bunjah Umar Danladi^{1*}, Adejoh-Ubani Elizabeth Ojoma²,
Rufina Obioma Okeke³, Edward Christopher Dung⁴, Japheth Joel Kalang⁵,
Danjuma Reuben Tom⁵ and Stanley David Oziegbe⁶**

¹ *Livestock Department, Agricultural Research Council of Nigeria, Nigeria.*

² *National Animal Production Research Institute, Poultry Unit, Shika Zaria, Nigeria.*

³ *National Biotechnology Development Agency Lugbe Airport, Road Abuja, Nigeria.*

⁴ *Department of Veterinary Physiology, Pharmacology and Biochemistry, University of Jos, Nigeria.*

⁵ *Department of Veterinary Medicine, Surgery and Radiology, University of Jos, Nigeria.*

⁶ *Department of Theriogenology and Production, Faculty of Veterinary Medicine, University of Jos, Nigeria.*

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

The goal of this research was to identify the genetic pool of the Bunaji and Sokoto-Gudali cows using haemoglobin (Hb) polymorphism. Blood samples were collected from a total of 150 mature Bunaji, Sokoto-Gudali and HolsteinXBunaji cows in north western Nigeria. To reveal the band patterns of haemoglobin, the red cell lysates were treated to cellulose acetate electrophoresis and a particular staining process. Individual cattle were found to have three co-dominant alleles, resulting in three genotypes (AA, AB, and AC). The A and B alleles had gene frequencies of 0.62 and 0.38, respectively. In the cattle population, the corresponding genotype frequencies for AA, AB, and AC were 0.34, 0.57, and 0.10, respectively. The variation between the observed and the expected

genotype number was not significant ($P>0.05$) thereby conforming with Hardy-Weinberg frequencies. There is a need for further study to determine the association between morphological traits with haemoglobin polymorphism using high resolution DNA markers for detailed understanding of health status and breed characteristics of indigenous cattle in north western Nigeria.

Keywords: Haemoglobin; polymorphism; morphometric traits; cattle; Nigeria.

1. INTRODUCTION

One key component of a strategy to expand food security is genetic characterisation of indigenous breeds and their biochemical properties [1]. In Nigeria, several studies on diverse livestock species have been published [2]. Due to low production, local indigenous breeds have gotten less attention, causing breeders to transfer their focus to temperate cattle breeds in order to improve their local physiological, biochemical, and metabolic products/markers and farm animal productivity efficiency [3]. The physiological basis of performance qualities and the influence of heterosis have been investigated using biochemical traits such as blood types, blood proteins, and enzymes [4]. The traditional approach to better animal breeding is based on phenotypic differences found within and between related groups of individuals, although they are only partly attributable to genetic differences and partly owing to environmental factors. Haemoglobin is a blood protein that is made up of four globin chains (two each of alpha and beta) plus a prosthetic group called haem [2]. Human haemoglobin was the first protein to be investigated, and it continues to be the most studied blood protein [5]. Several studies in cattle and sheep have already connected these markers to production qualities and environmental adaptation, in addition to several critical activities of blood proteins [6]. According to the report of [7], it was found that Romanian Brown cows in Moldavia with haemoglobin type AB had higher milk yield (2271–2900 vs 1900–2471 litres) and milk fat yield (84.6–105.0 vs 67.5–103.7 Kg) than other kinds (AA, BB). In terms of milk yield and fat percentage, BB cows were shown to be inferior to the other two categories (AB, AA). According to [7] Romanian Brown Cows of Hb types A, AB, and B had an average first calving age of 45.14, 40.52, and 36.66 months, average milk yields of 2478, 2578, and 2277kg, and average fat yields of 95.78, 95.78, and 95.78, respectively [8] found that Hb types significantly age at first calving in all groups except Holstein crossbreds, service period in

Brown Swiss crossbreds, and milk yield in Brown Swiss crossbreds and Hariana purebreds in crossbreds (Holstein X Hariana, Brown Swiss X Hariana, Jersey X Hariana) and Haria Cattle. Although morphological classification of cattle has been attempted in Nigeria [9]), there is a scarcity of information on their molecular characterization. Therefore, the present investigation aimed at describing the genetic structure from the level of the determinant locus of haemoglobin variants in Bunaji, Sokoto-Gudali and FriesianXBunaji cattle.

2. MATERIALS AND METHODS

2.1 Location of the Experiment

The study was place at the Dairy Breeding Unit of National Animal Production Research Institute (NAPRI), Shika, Zaria, Kaduna State. NAPRI is geographically located between latitude 11° and 12° N and longitude 7° and 8° E at an altitude of 640m above sea level.

2.2 Animals and Management

National Animal Production Research Institute (NAPRI) provided the animals for this study . They were raised in a semi-intensive management regime. A total of 150 cattle comprising of equal number of Friesian X Bunaji cross (N=50), Sokoto Gudali (N=50) and White Fulani (N=50) were used for the study.

2.3 Blood Collection

Separated red cells were washed in saline solution before being lysed with distilled water. With a modest adjustment [10], haemoglobin was typed using cellulose acetate electrophoresis as described by [11]. The migration speed of the light spots on the electrophoretical substratum, detected from the start line towards the cathodal zone, was used to identify the haemoglobin types in cattle. Hb bands were scored using the direct

gene counting method based on the separation of Hb variants.

2.4 Statistical Analysis

Genotype and gene frequencies of Haemoglobin (Hb) alleles were estimated according to Hrinca (2008). Data on Hb alleles and of genotype frequencies were subjected to chi-square analysis to test for goodness-of-fit for observed and expected frequencies under Hardy-Weinberg equilibrium (HWE). Heterozygosity (H) was estimated as the expected proportion of heterozygotes under HWE using J.M.P genomics software.

3. RESULT AND DISCUSSION

3.1 Genotype and Gene Frequencies of Haemoglobin among Breeds

Table 1 presents the gene and genotypic frequencies of haemoglobin variants. The observed and expected numbers were also indicated. In the Bunaji, the count and frequency were HbAA (5.00 and 0.24), HbAB (12.00 and 0.57), HbBB (4.00 and 0.19) while allelic frequency indicated similar count and frequency of HbA (11.00 and 0.52) and HbB (10.00 and 0.48). The Friesian X Bunaji cross indicated (3.00 and 0.25), (7.00 and 0.58) and (2.00 and 0.17) respectively for genotypes observed; (6.50 and 0.54) and (5.50 and 0.46) for allelic counts and frequencies. In the Gudali the following were observed for the genotype; (20.00 and 0.40), (28.00 and 0.56) and (2.00 and 0.04) while the allelic counts and frequencies were (34.00 and 0.68) and (16.00 and 0.32) respectively. The χ^2 value 1.27 was not significant ($p > 0.05$) indicating conformity to Hardy-Weinberg equilibrium for the haemoglobin loci across all the breeds. The biochemical processes are used for the research of breed origin, examining structure and relations between breeds, and for the correlations that can be established with many traits like production and disease resistance due to their polymorphic nature, large number, and simple Mendelian pattern of inheritance [12]. Though after the widespread use of molecular characterization techniques, the enthusiasm of biochemical polymorphism studies has gone down considerably, however, it is still popular

especially in the developing world where sophisticated lab facilities are not readily available. The frequencies 0.62 (HbA) and 0.48 (HbB) obtained for the pooled Bunaji, Friesian X Bunaji and Gudali cattle populations were comparable to the report of 0.64 and 0.36 respectively reported by [12] for Zebu cattle and their crosses in Zaria. The higher frequencies of HbA (0.52, 0.54 and 0.68) obtained respectively for the Bunaji, Friesian X Bunaji and Gudali cattle were consistent with the observation of [13] that most of the animals studied revealed a high genotypic frequency of 0.518 for HbAA in haemoglobin types in Bunaji cattle and their Friesian crosses in Shika, Zaria-Nigeria. The Preponderance of the HbAB over the HbAA and HbBB across all the breeds and in the pooled information were consistent with the report that Zebu cattle and their crosses with HbAB show a high degree of dominance over HbAA and HbBB and this was a result of natural selection [12]. Also the lack of significant ($p > 0.05$) variation among the frequencies observed also agreed with the findings of [14]) and may perhaps, apart from pointing to the stability of the population with regards to these genes, indicate that the Zaria environment may be favouring the HBAA genotype by natural selection, this observation confirms the conclusion of [14] that Hb type AA in the Nigerian Friesian-Bunaji crosses of cattle of Zaria environment was favoured by natural selection, possibly for adaptation against the hot tropical weather and tolerance of tick and helminthic infections which was not achievable with exotic cattle breed. Also [15] in reporting the effect of age, sex and haemoglobin type on adaptive and blood biochemical characteristics of Red Sokoto goats have stated that the variation of Hb type with adaptive and blood biochemical characteristics was significant ($P < 0.05$) and that the relationship between Hb types and HR can be linked to the different oxygen carrying capacity of the Hb types. In their study, higher Heart Rate was observed in goats with HbAA and HbAB, and HbA is known to be the haemoglobin allele with highest affinity for oxygen. This is in line with the earlier report of [15] who related the preponderance of HbA to greater affinity for oxygen, thus explaining the high adaptive coefficient they observed on goats with Hb types AA and AB since adaptive coefficient is a function of Heart Rate and Rectal Temperature.

Table 1. Genotype and Gene Frequencies of Haemoglobin among different Breeds of Cattle (N=150)

Variable	Genotype			Gene		χ^2 df=4 1.27	LOS NS
	AA	AB	BB	A	B		
Overall							
Observed	28.00	47.00	8.00	51.50	31.50		
Expected	27.70	27.70	27.70	41.50	41.50		
Frequencies	0.34	0.57	0.10	0.62	0.38		
Bunaji							
Observed	5.00	12.00	4.00	11.00	10.00		
Expected	9.00	9.00	9.00	10.50	10.50		
Frequencies	0.24	0.57	0.19	0.52	0.48		
Friesian X Bunaji							
Observed	3.00	7.00	2.00	6.50	5.50		
Expected	4.00	4.00	4.00	6.00	6.00		
Frequencies	0.25	0.58	0.17	0.54	0.46		
Gudali							
Observed	20.00	28.00	2.00	34.00	16.00		
Expected	16.70	16.70	16.70	25.00	25.00		
Frequencies	0.40	0.56	0.04	0.68	0.32		

NS-Not significant; LOS-Level of Significant

4. CONCLUSION

The study revealed overall frequencies of 0.62 (HbA) and 0.48 (HbB). Higher frequencies of the A allele (0.52, 0.54 and 0.68) were obtained respectively for the Bunaji, Friesian X Bunaji and Gudali cattle in the Haemoglobin locus. However, it was noted that the heterozygote genotype for most of the locus in different breed were superior to the homozygote.

ETHICAL APPROVAL

Animal Ethic committee approval has been taken to carry out this study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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