Nigerian J. Anim, Sci. 2025, 27 (2): 18 - 26

Association Between Heamoglobin-types and Morphometric Traits in Three Nigerian Goat Populations

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Target audience: Animal breeder, researchers, animal scientists, ruminant specialists, learners in animal science

Abstract

A total of 100 Nigerian native goats (Borno white, Sokoto red and West African Dwarf, WAD) reared in Maiduguri were examined for five morphometric traits and relationship with heamoglobin-types. Heamoglobin types were screened using Cellulose Acetate Electrophoresis procedure and estimated using Hardy-Weinberg Equation. Morphometric data (height at wither, back length, paunch circumference, heart girth and canon circumference) were analyzed using General Linear Model and significant means were separated using Duncan Multiple Range Test. The result revealed three Heamoglobin variants with two codominant alleles (HbA, HbB) in Borno white and WAD while Sokoto red goat had only two, AA and AB Hb types. Generally, goats with Hb BB had significant (P<0.05) paunch circumference (79.34 cm). Heamoglobin types for Borno white and WAD had no significant (P>0.05) effects on morphometric traits while Sokoto red goat with Hb AB had significantly (P<0.05) higher height at wither (64.52 cm). Hb AB could be regarded as candidate genotype with higher values for most morphometric traits in the goat populations. Sokoto red goat should be conserved to prevent extinction and could be improved for body weight.

Keywords: Goat, HWE, genotype, WAD, Borno white

Description of Problem

Nigeria is endowed with large small ruminant resources in Africa boasting of about 73.8 million goats which boosted the livestock sub-sector in the country's Gross Domestic Product (GDP) to N221.13 billion (5.6%) (1), (2). This is an attestation that small ruminants (sheep and goats) occupy a vital part of livestock produce. Among other importance, they play a significant role in the sustenance of livelihoods of less-able families (3); (4). As stated by (5), these animal genetic resources represent 63.70% of the total grazing domestic animals (6).

Goat (*Capra hircus*) is regarded as the first farm animal domesticated for economic interest around 9000-10000 BC thought to have been brought by migrant pastoralists from Asian to African continent (7); (8).

Domestication influence were manifested in ears, horns, colour and hair type believed to have arisen from natural mutation and artificial selection by early goat farmers. Subsequently, this led to physical differentiation into breeds and types. Goat husbandry has been in practice for centuries in Nigeria contributing immensely to country's economy and food security (9); (10). In West Africa sub-continent, Nigeria has the largest goat population with approximately 76 million goats recorded in 2019 (11). Goat is a household animal with a great importance in the livelihood of the rural people in Nigeria. Among other merits, goats supply human population with meat, milk, skin, hair and other products (3); (12).

West African dwarf (WAD) goat is most abundant in the south western states of Nigeria usually reared for meat under extensive system of management (13). Red Sokoto goat being one of the most important indigenous breeds in Nigeria, is known for good adaptable potentials for the climate of northern Nigeria (3). The long-legged/Sahel is a goat found in the arid and Sahel regions of Nigeria with ability to withstand heat stress (14).

Body measurements are important for the prediction of live and carcass weight as well as determination of certain body conformation traits that could be essential ingredients in the selection of animals for genetic improvement (8). On the other hand, the polymorphic variants of different blood proteins such as heamoglobin represent accurate procedures for a better measurement of genetic variation in different animal species. Studies in ruminants have related different heamoglobin types to production traits (15); (16). For instance, Sam (17) observed that North Western Nigeria goats with AA Hb types were superior to others in conformation-related traits. Similar findings were made by (18) for goats in North Central Nigeria. Significantly lower body weight in cattle with Hb AA was reported by (19). This study therefore intended to determine the association between heamoglobin genotype and morphometric traits in three Nigerian goat populations reared in Maiduguri, Borno sate.

Materials and Methods

This investigation was conducted in the capital city of Borno state, Maiduguri, Northeast Geo-political zone of Nigeria. The city lies on Latitude 11^0 50' 48.91" N and Longitude 13^0 09' 25.63" E (20). Maiduguri lies within the Sudano-Sahelian ecological zone, characterized by a semi-arid climate with distinct wet and dry seasons (21). A total 100 Nigerian native goats (Borno white, 53: Sokoto red, 26; and West African Dwarf, 21) were selected from goats prepared for slaughtered in Maiduguri abattoir. One hundred blood samples were collected when the animals were being slaughtered into well-labelled bijou bottles with Ethylene-diamine tetra-acetic acid (EDTA) as anticoagulant and were taken to the laboratory in flask containing ice and kept in refrigerator at 5 ^{o}C until laboratory analysis.

Morphometric data were collected from five morphometric traits: height at wither, back length, paunch circumference, heart girth and canon circumference. The traits were measured as described below:

Height at wither was measured as distance from the ground to the point of the wither using a tape calibrated in centimetre.

Heart girth was taken as the circumference the chest using a tape calibrated in centimetre.

Paunch circumference was measured as the circumference round the abdominal part using a tape calibrated in centimetre.

Back length was measured from the top point of the shoulder to the pin bone using a tape calibrated in centimetre.

Canon circumference measured as the circumference of lower part of foreleg just above the hoof using a tape calibrated in centimetre.

One hundred (100) blood samples were collected from the animals during slaughter in Maiduguri abattoir into 5 ml bijou tubes (13 x 75 mm) with Ethylene-diamine tetra-acetic acid (EDTA- K3) as anticoagulant with ethical approval from the Veterinary officers in the abattoir. The samples were refrigerated pending electrophoresis. Samples were prepared and were subjected to cellulose acetate electrophoresis. Blood samples were prepared, thereafter different tubes containing the samples were centrifuged at 4000 rpm for 10 minutes. The supernatant was discarded and samples were rewashed with 10 ml of cold distilled water. Then, 0.115ml NaCl was added to wash the cell. The supernatant was then discarded and the different sediments were rewashed using 2 ml of cold distilled water. The remaining serum and plasma were centrifuged. Cold distilled water was added to the sediment to re-suspend the cells in order to release the heamoglobin by hemolysis. When the lysate was well separated after standing, it was stored at refrigeration temperature (5 ^{0}C) pending electrophoresis.

Cellulose acetate electrophoresis

Cellulose acetate strips were prepared and labeled. These were thereafter soaked in EDTA borate buffer with pH 8.6 and blotted slightly with filter paper to remove excess buffer. Applicators were used to impregnated the samples (hemolytes) on the cellulose acetate paper. These were thereafter placed on the electrophoresis tank (CHIBEST electrophoresis tank) using forceps. Tank was powered with the lid closed allowing samples to separate for 10-15 minutes. Thereafter, the cellulose acetate papers were blotted dry using filter paper and then dried in an open air for some minutes and the result was taken. The direct gene counting method (22) was used to score the resulting heamoglobin bands based on separation of heamoglobin variations:

- The presence of a single faster band was designated as AA homozygote;
- The presence of a single slower band was designated as BB homozygote; and
- The presence of both bands was designated as AB heterozygote.

Laboratory analyses including procedures of Cellulose Acetate Electrophoresis and heamoglobin screening were done at Department of Animal Science Laboratory, Faculty of Agriculture, University of Maiduguri, Maiduguri, Borno state, Nigeria.

Estimation of genotype and gene frequencies

Genotype frequencies were calculated using the following fomular:

$$P= \frac{\text{No of AA}}{N} \times \frac{100}{1}$$

$$H = \frac{\text{No of AB}}{N} \times \frac{100}{1}$$

$$Q = \frac{\text{No of BB}}{N} \times \frac{100}{1}$$

Gene frequencies were calculated according to Hardy-Weinberg equation as follows:

$$p = \frac{2(N_{AA}) + N_{AB}}{2N}$$

$$q = \frac{2(N_{BB}) + N_{AB}}{2N}$$

P= Genotype frequency of allele AA
H= Genotype frequency of allele AB
Q= Genotype frequency of allele BB
p= Gene frequency of allele A
q= Gene frequency of allele B
N = Total number of individuals sampled
N_{AA} = Observed genotype number for AA
N_{AB} = Observed genotype number for AB
N_{BB} = Observed genotype number for BB
Data generated from morphometric traits were analyzed using General Linear Model (GLM) and Post Hoc. All statistical analyses were handled by SPSS V. 20 (23). The following model was adopted for the GLM:

$$Y_{ijk} = \mu_0 + B_I + C_j + e_{ijk}$$

Where Y_{ijk} = observation belonging to $_{ijk}$ classification
μ_0 = Overall mean
B_i = effect of ith breed (i =1, 2, 3)
C_j = effect of jth heamoglobin genotype (j =1,2, 3)
e_{ijk} = random error

Results and Discussion

Effect of heamoglobin genotype on morphometric characters for Nigerian native goat breeds is shown in Table 1. Two alleles (Hb^A, Hb^B) were detected in the population. These govern three heamoglobin-types; the dominant and recessive homozygotes (AA, BB) and heterozygous type (AB). by implication, the population is not homogenous. Detection of two alleles at heamoglobin loci is in accordance with earlier works on heamoglobin-types in ruminants especially sheep and goats (24); (25); (26). This outcome indicates that this population is in line with Hardy-Weinberg Equilibrium (HWE) as all the three heamoglobin=typed were present in the population. In other words, the population had not been badly influenced by systematic or non-systematic forces that affect genotype and gene frequencies in a population. Out of all the five traits examined, significant ($P<0.05$) effect of heamoglobin-types was observed on paunch circumference. Goats with Hb BB had significantly higher paunch circumference than those of Hb AA or AB. In spite of their non-significant ($P>0.05$) levels, goats with heamoglobin Hb BB had highest values for other traits. This shows the superiority of goats with BB Hb for these morphometric characters to others of different genotypes. Heart girth and paunch circumferences are good measures and predictors of body weight of an animal. By implication, goat populations with Hb BB types could be best selected for improved body weight.

The results of association between heamoglobin types and morphometric traits for goat populations in Maiduguri based on breeds are shown in Tables 2 to 4. Two codominant alleles (Hb^A, Hb^B) were detected governing three genotypes (AA, AB and BB) in Borno white (Table 2). There was no significant (P>0.05) effect of heamoglobin-type on morphometric traits. although not significant, Borno white goat with heamoglobin AB was however demonstrated higher values for all the morphometric traits examined. The non-significant effect of heamoglobin type on morphometric traits observed in the current study had earlier been recorded by (24) in sheep and goats.

Unlike the result of effect of heamoglobin type on morphometric traits observed for Borno white goat, only two heamoglobin-types (Hb AA, AB) were observed for Sokoto red goat population under the control of Hb^A and Hb^B. Hb BB was completely absent in this population (Table 3). This might be indicative of deviation from Hardy-Weinberg Equilibrium. The expectation is that, the three heamoglobin variants (AA, AB and BB) are obtainable in every population otherwise, complete absence suggests deviation from HWE. By implication, this population might have been influenced by non-systemic factors of genotype and gene frequencies. Meanwhile, significant (P<0.05) relationship was recorded for heamoglobin-type and morphometric traits in Sokoto red goat. Goat with Hb AB had significantly higher height at wither (64.52 cm) where no significant (P>0.05) effect of heamoglobin was identified with other traits. Similar to our results, (17), (18) observed no significant relationship between most of the body parameters and haemoglobin polymorphism. However, (27) reported that individual goats with Hb BB genotypes were significantly superior in body weight, heart girth, neck length and shoulder widths than Hb AB and Hb AA. This shows some discrepancies with our results which may be due to variations in the population examined. Our results on the other hand revealed that goats with Hb AB showed non-significant (P>0.05) higher values for back length (61.86 cm) and paunch circumference (74.26cm) which might be an indication of good

Table 1: Effect of heamoglobin genotype on morphological characteristics in Nigerian native goat populations

Trait	Heamoglobin Genotype		
	AA	AB	BB
Height at wither	66.28^a	65.89^a	67.84^a
Back length	61.38^a	60.86^a	64.19^a
Paunch circumference	74.38^{ab}	73.85^c	79.34^a
Heart girth	63.29^a	65.09^a	66.06^a
Canon circumference	7.77^a	7.66^a	8.02^a

potential for meat production. Hb AB could be regarded as candidate genotype for this goat population in Maiduguri. This is in accordance with the work of (27) who suggested that Hb AB can be the genotype of interest in goats of Maiduguri. Therefore, this goat population could be conserved to guide against extinction and subsequently selected for improved body weight.

Table 2: Association between heamoglobin genotype and morphological characteristics in Borno white goat population

	Heamoglobin genotype			
Trait	**AA**	**AB**	**BB**	**Significance**
Height at wither	63.92	65.96	64.62	ns
Back length	60.20	62.15	59.69	ns
Paunch circumference	70.69	75.40	72.24	ns
Heart girth	63.28	65.35	63.21	ns
Canon circumference	7.57	7.67	7.62	ns

Table 3: Association between heamoglobin genotype and morphological characteristics in Sokoto red goat population

	Heamoglobin genotype			
Trait	**AA**	**AB**	**BB**	**Significance**
Height at wither	55.88^{b}	64.52^{a}	-	**
Back length	57.91	61.86	-	ns
Paunch circumference	70.61	74.26	-	ns
Heart girth	65.53	63.56	-	ns
Canon circumference	7.82	7.71	-	ns

Table 4: Association between heamoglobin genotype and morphological characteristics in WAD goat population

	Heamoglobin genotype			
Trait	**AA**	**AB**	**BB**	**Significance**
Height at wither	58.42	64.15	63.50	ns
Back length	63.81	60.48	52.07	ns
Paunch circumference	72.88	69.10	60.96	ns
Heart girth	66.67	64.39	62.79	ns
Canon circumference	7.55	7.85	7.36	ns

Similar to the result for Borno white in this study, heamoglobin genotype was not a source of variation among morphometric traits in WAD goat population (Table 4). This is in line with the findings of (26) who observed no significant relationship between heamoglobin-type and morphological traits. WAD with Hb AA demonstrated superiority for back length, paunch circumference and heart girth though no significant difference (P>0.05) was observed. This suggests its compact body composition even though the breed is small body-sized. This result correlates well with the report of (24) who reported higher values of morphometric traits in does and bucks with AA Hb types. This result also suggests that West African Dwarf goats with AA Hb types are reservoir of good quality meat. Therefore, WAD with AA Hb could be improved for meat production.

Conclusions and Applications

1. Heamoglobin types had no influence on morphometric traits of both Borno white and WAD goat populations.
2. Sokoto red goat with Hb AB had higher height at wither and could be regarded as candidate genotype for meat production in these goat populations.
3. Sokoto red goat with Hb AB could be selected for improved body weight.

Acknowledgements

We are grateful to the Chief Veterinary Officer and his team of scientists and staff of Maiduguri Abattoir, Borno state for providing conducive environment and giving ethical approval during blood sample collection.

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