

HAEMOGLOBIN POLYMORPHISM OF GOATS IN SOUTHERN KADUNA

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ABSTRACT

Blood samples were collected in heparinized test tubes from 100 smallholder goats in four local government areas (Jema'a, Kaura, Jaba, and Kachia) of Southern Kaduna. The blood samples were collected and analysed by electrophoresis to study the haemoglobin polymorphism and its frequency in indigenous smallholder goats found in Southern Kaduna. The electrophoretic test showed the presence of two co-dominant alleles HbA and HbB which produced two haemoglobin phenotypes: A homozygote HbAA and heterozygote HbAB; HbBB was not detected in this study. HbAA (61%) had the highest frequency over HbAB (39%). The gene frequency of HbA (0.805) exceeded HbB (0.195) significantly. The high preponderance of HbA allele is seen as an adaptation due to several environmental factors such as height above sea level (altitude) for oxygen utilization, temperature extremes, and presence of parasitic helminthes. The chi-square test showed high significant differences between observed and expected genotype frequencies ($P < 0.01$). Thus, indicating that the flock was not in Hardy-Weinberg's equilibrium.

Key words: Goat, haemoglobin, haemoglobin polymorphism, electrophoresis, and adaptation.

INTRODUCTION

The domestic goat or simply goat (*Capra aegagrus hircus*) is a subspecies of *Capra aegagrus* domesticated from the wild goat of South Asia and Eastern Europe. They are a valuable source of animal protein for humans when their meat or milk is consumed. Indigenous goats in Nigeria belong to three distinct breeds: the long-legged Sahel/desert goat found in the arid and Sahel regions; the relatively small body-sized red Sokoto goat found in the savannah zone; and the hardy, short-legged West African Dwarf (WAD) found mostly in the South. Although goat breeding is a very old tradition among indigenous farmers, no purposeful breeding programme has ever been organized for the species in Nigeria. Goat breeds have been previously evaluated for genetic variation based on morphological, physiological, pathological, productive, reproductive and behavioural features (Pourlis and Christodoulous 2008; Salako *et al.*, 2007). However, these characters underestimate the true level of genetic variation. The amount of genetic variation detectable in an animal population is related to the magnitude of genetic improvement achievable within the species (Salako *et al.*, 2007; Akpa *et al.*, 2011). Therefore, the polymorphic variants of different proteins, enzymes, and mineral element or blood group factors represent more accurate procedure for better measurement of genetic variation in goat species. One of the important blood proteins is haemoglobin because of its biochemical, biophysical and physiological properties, having relevance to selection phenomenon of animals (Menrad *et al.*, 2002). Haemoglobin have been previously reported to have variants (polymorphism) and these variants have been reported to be associated with environmental adaptability as well as being clinically important as causes of a variety of genetic disorders of blood (Peter *et al.*, 2004).

The objectives of this study were: to assess haemoglobin polymorphism which exists in goats found in Southern Kaduna; to assess the frequencies of the haemoglobin variants of goats found in Southern Kaduna; and to relate the predominant haemoglobin polymorphic form to the type of environment the goats thrive in.

MATERIALS AND METHODS

Study area

The study was carried out in four local government areas in the Southern part of Kaduna state: Kachia, Jaba, Jema'a, and Kaura local government area.

Data collection

Blood samples (5ml) were collected from 100 goats (25 goats from each local government) in four local governments of Kaduna state: Kachia, Jaba, Jema'a, and Kaura local government area. 5ml of blood was collected from each of the sampled animals by jugular venipuncture using needle and syringe and into sample bottles containing Ethylene Diamine Tetra Acetic acid (EDTA) as

anticoagulant, properly labelled with respect to the different breeds and local governments and preserved in a fridge from whence it is transported to the laboratory for analysis.

Electrophoresis

The red cell lysate was impregnated on a cellulose acetate paper with a control, placed on the electrophoresis tank and subjected to electrophoresis according to the standard procedure described by Smithies (1955) that was later modified using the procedure of Boyer and Hiner (1963). By electrophoresis, the haemoglobin fractions were separated. The identification of the haemoglobin types in the samples was achieved in accordance with the migration speed of the light spots on the electrophoretic substratum, detected from the start line towards the cathodal zone. The haemoglobin polymorphism was pointed out by detection of three migration zones coded as follows: A single faster band designated as AA homozygote, a single slower band designated as BB homozygote, and the presence of both bands designated as AB heterozygote.

RESULTS AND DISCUSSION

Table 1: Genotypic frequencies of the indigenous goats in the sampled local governments

Local govt	N	AA%	AB%	BB%	Total
Jema'a	25	68.00	32.00	0.00	100.00
Kaura	25	60.00	40.00	0.00	100.00
Jaba	25	84.00	16.00	0.00	100.00
Kachia	25	32.00	68.00	0.00	100.00
Polled	100	61.00	39.00	0.00	100.00

Result on genotypic frequencies of the indigenous goats in the sampled local governments is presented in Table 1. The results obtained revealed that AA genotype had the highest frequency across all sampled local governments areas (Jema'a: 68%, Kaura: 60% and Jaba: 84% respectively) except for Kachia local government where AB has the highest genotypic frequency of 68%. The AB genotype had the second highest frequency across the local government areas (32%, 40%, and 16% for Jema'a, Kaura, and Jaba, local government area respectively) except in Kachia local government where it had the highest frequency of 68%. The BB genotype had the lowest genotypic frequency of 0%.

Table 2: Gene frequencies of the indigenous goats in the sampled local government

Local govt	N	A (P)	B (Q)	Total (P+Q)
Jema'a	25	0.84	0.16	1.00
Kaura	25	0.80	0.20	1.00
Jaba	25	0.92	0.08	1.00
Kachia	25	0.66	0.34	1.00
Polled	100	0.805	0.195	1.00

Result on gene frequencies of the indigenous goats in the sampled local governments is presented in Table 2. The result showed that the HbA gene had the highest gene frequency across the four local governments (Jema'a: 0.84, Kaura: 0.8, Jaba: 0.92, and Kachia: 0.66 while the B gene had the lowest gene frequency in all four local government areas (Jema'a: 0.16, Kaura: 0.2, Jaba: 0.08, and Kachia: 0.34).

Result from chi-square analysis showed that there was high significant difference between observed data and expected data.

Relationship between genotype and environment

In this study, two haemoglobin genotypes were detected: homozygote (AA) and heterozygote (AB). No homozygote BB was detected in this study. The genotypic frequency of AA (61%) genotype was significantly higher than AB (39%) when polled together, from table 1. The results of this study is similar to the works of Agaviezor *et al* 2013 in which they recorded significantly higher frequency of AA genotype (75%) over AB genotype (21.67%) and BB genotype (3.33%) of indigenous goat breeds living in areas of dense vegetation. Buvanendran *et al* 1981 did not find the BB phenotype in red

sokoto breeds. Johnson *et al* 2002 reported that the BB genotype is not widely distributed. Agaviezor *et al* 2013 suggested that the AA genotype may have selective advantages against helminthic infections.

Hrinca (2010) explains that extreme temperature (acute cold or sultry heats), the extreme forms of relief (dessert or mountain) and precarious nutrition conditions favour the fixing of the allele HbA, and the temperature situated in the biological comfort zone, the moderate forms of relief (forest steppe, hill, etc) or the optimal breeding technologies are correlated with a more emphasized fixing of the allele HbB. The present study was done in the northwest of Nigeria where the temperature could be as high as 38°C. This high temperature could probably favour the fixing of HbA over HbB. Salako *et al.* (2007) reported that Red Sokoto goats sampled in the South West of Nigeria (Rain forest zone) had a higher frequency of HbB to HbA, suggesting that they best fit in zones of moderate temperature. Evans and Warren (1958), explained that HbA genes are favoured in environment of high altitudes, while HbB are favoured by lower altitudes. The population sampled in this study came from high altitude areas of 2021ft (616m) above sea level. This may explain the higher frequency of HbA than HbB. Salako *et al.* (2007) reported higher frequency of HbB than HbA in their study; they sampled animals from a lower altitude (Ibadan is 780ft above sea level; Falling Rain Genomics Inc. 1996-2006). Das *et al.* (2004) also reported a higher frequency of HbB in Kolkata, West Bengal India (altitude 42ft). Alphonsus *et al.* 2012 also reported a high preponderance of HbA alleles (0.60) over the HbB alleles (0.335) of indigenous goats found in the in the Northern region of Nigeria. Likewise, Akpa *et al.* (2011) reported a high preponderance of HbA alleles in the indigenous goats of Northern Nigeria. These findings suggest that the natural habitat of Northern Nigeria favour goats with HbA alleles than HbB alleles. However, some studies by Das *et al.* (2004) and Salako *et al.* (2007) in goats of southern Nigeria revealed high preponderance of HbB alleles than HbA. This variation is probably due to differences in the geographical locations especially with regard to their altitudes. The southern part where Salako *et al.* 2007 and Das *et al.* 2004 conducted their study was in a relatively lower altitude (750ft and 42ft respectively); while the study of Alphonsus *et al.* (2012) and Akpa *et al.* (2011) were conducted in a relatively high altitude (2552ft) of the Northern part.

CONCLUSION

Haemoglobin polymorphism is defined by the expression of different variant (polymorphic) forms of haemoglobin. Two types of haemoglobin genotypes were found in this study, HbAA and HbAB; generally 61% of the goats had HbAA genotype while 39% had HbAB genotype. The allelic (gene) frequency for HbA was 0.805 while the allelic frequency for HbB was 0.195. This suggests that goats possessing the HbA allele had a higher chance of survival and reproduction as they might be better at utilizing oxygen, more tolerant to extreme weather conditions, and have higher resistance to helminths.

The chi-square test revealed high significant differences between observed data and expected data which show that the goat population were not in Hardy Weinberg's equilibrium suggesting differential mortality and preferential selection for particular genotypes which are more suited to the environment.

RECOMMENDATION

1. Haemoglobin variants should be put into consideration in goat's selection and breeding programs.
2. Environmental factors should always be assessed before goats are being introduced so that the goats with the most suitable genotype can be chosen.
3. Larger scale studies needs to be done to give a better understanding of how environmental factors interact with Haemoglobin forms and how these polymorphic forms interact with other biochemical factors in the animal.

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