HAEMOGLOBIN POLYMORPHISM, INBREEDING COEFFICIENT AND DEGREE OF HETEROZYGOSITY OF SELECTED ANIMALS IN KOGI STATE UNIVERSITY LIVESTOCK FARM

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ABSTRACT

Sixty five animals (10 sheep, 30 goats and 25 cattle) were used to evaluate haemoglobin (Hb) polymorphism, local inbreeding coefficient and the degree of heterozygosity in animals reared at the livestock farm of the Kogi State University, Anyigba using cellulose acetate gel electrophoresis. Results showed that HbAB was predominant in cattle (0.52) followed by HbBB (0.32) and HbAA (0.16) with a gene frequency of 0.42 and 0.58 for the A and B gene locus, respectively. In sheep, only HbAA was observed in the animals sampled with genotype frequency of 1.00 and gene frequency of 1.00. In goats, HbAA was more with genotype frequency of 0.80, followed by HbAB (0.20) while HbBB was not observed. The gene frequency for the A and B locus were 0.90 and 0.10, respectively. The local inbreeding coefficient and expected Heterozygosity were: cattle (-0.08 and 0.48), sheep (0.00 and 0.00) and goats (-0.11 and 0.18), respectively. It was concluded that all the genotypes evaluated were in Hardy-Weinberg equilibrium as there were no significant differences observed between the observed and expected genotypes.

Keywords: *Haemoglobin, inbreeding coefficient, Heterozygosity, cattle, sheep, goat.*

INTRODUCTION

Haemoglobin (Hb) is a coloured blood protein which is very important for its role in the transportation of oxygen to tissues, and carrying away carbon dioxide (CO_2). It is the first blood protein to be studied (Osterhoff, 1964) and its inheritance follows simple Mendelian fashion (Akinyemi and Salako, 2010). Due to this characteristic, Hb can be used as a biomarker for selection purposes in farm animals. Differences exist in the structure of Hb mainly in its globin component and this difference leads to variants of Hb, which may confer or limit the animal's abilities/productivities. Egena and Alao (2014) in their review of Hb polymorphism in selected farm animals; observed that variation in Hb have led to selective advantages in different geographical areas. Such selective advantages include resistance to helminth infestation (FAO, 1988), effect on meat quality (Bezova *et al.*, 2007), productive traits (Barowicz and Pacek, 1984; Arora, 1984) and even on hair and horn length (Akinyemi and Salako, 2010). A search of literature revealed that this type of study has not been carried out in Kogi State, Nigeria. This study therefore is a pilot work which focuses on the identification of genetic diversity amongst the White Fulani cattle, Yankasa sheep and West African Dwarf goats reared at the Kogi State University, Nigeria livestock farm via electrophoretic detection of polymorphism at the Hb locus.

MATERIALS AND METHODS

The animals used for this study were from the livestock farm of the Kogi State University, Anyigba, Nigeria. The animals are semi-intensively managed. A total of sixty five animals (10 sheep, 30 goats and 25 cattle) were used for the study. Sampled animals were adults within breeding age group. 2ml of blood was collected from each of the sampled animals by jugular venipuncture into a test tube containing Ethylene Diamine Tetra Acetic acid (EDTA) as anticoagulant and properly labelled. The blood samples were lysed directly using distilled water without any prior washing with saline water and the red cell lysate subjected to electrophoresis in a cellulose acetate gel medium according to standard procedure (Imumorin *et al.*, 1999). The Hb types were identified based on their migration on the electrophoretic substratum detected from the start line towards the cathode zone. The resulting frequencies of the allele corresponding to the banding pattern were estimated by direct count. Haemoglobin genotype and gene frequencies were estimated as follows:

$$\text{Genotype frequency of AA} = \frac{\text{number of individuals with AA}}{\text{number of individuals sampled}} \times 100$$

$$\text{Genotype frequency of AB} = \frac{\text{number of individuals with AB}}{\text{number of individuals sample}} \times 100$$

$$\text{Genotype frequency of BB} = \frac{\text{number of individuals with BB}}{\text{number of individual sampled}} \times 100$$

$$\text{Gene frequency of A} = \frac{2AA + AB}{\text{Total number of alleles}}$$

$$\text{Gene frequency of B} = \frac{2BB + AB}{\text{Total number of alleles}}$$

RESULTS AND DISCUSSION

Results of the study showed the haemoglobin distribution of HbAA, HbAB and HbBB for cattle to be 1, 7, 1 and 3, 6, 7; sheep being 6, 0, 0 and 4, 0, 0; while WAD goats were 9, 2, 0 and 15, 4, 0, respectively for the sampled male and female animals (Table 1, 2 and 3). The genotype frequency (Hb %) of the sampled animals (pooled) were: 16, 52 and 32% for cattle; 100, 0 and 0% for sheep and, 80, 20 and 0% for the WAD goat. The control of the three Hb genotype by the two co-dominant alleles A and B as observed in this study has been reported in Nigerian cattle, sheep and goat (Akinyemi and Salako, 2010; Akinyemi and Salako, 2012; Agaviezor *et al.*, 2013; Yakubu *et al.*, 2014). The absence of HbBB in goats is similar to the observation of Fésüs *et al.* (1983) in Hungarian Edelziegen native goat breed, Kuwar *et al.* (2001) in Nepalese Hill goats, Johnson *et al.* (2002) in Omani Dhofari goats and Yakubu *et al.* (2014) in WAD goats of Nigeria. The very low frequency observed for HbBB and HbAB in sheep is contrary to the report of Akinyemi and Salako (2012) who reported very high percentages of the genotypes among indigenous Nigerian sheep breeds. Pal and Mummed (2014) reported Hb polymorphism in cattle to be a global phenomenon as it has been reported in several countries (Han and Suzuki, 1976; Singh and Bhat, 1979; Anosa and Obi, 1980; Braend, 1988; Mojabi *et al.*, 2001), even though most of the studies seem to be concentrated on dairy cattle. The local inbreeding coefficient and heterozygosity observed in the study (-0.08 and 0.48 for cattle, - 0.11 and 0.18 for goat and, 0.00 and 0.00 for sheep) is presented in Table 1, 2 and 3. The results revealed that the level of inbreeding is quite low in cattle and goat while it is at the baseline in the sheep. There's usually an inverse relationship between inbreeding and expected heterozygosity. If inbreeding coefficient = 0, the observed heterozygote is equal to the expected number (as is observed in the sheep), which means that the population is in Hardy-Weinberg equilibrium; if it is = 1, there are no heterozygotes, implying a completely inbred population. Thus, the higher the inbreeding coefficient is, the more inbred the population is while the higher the degree of heterozygosity, the less inbred the population is. The values obtained for the two indices in the sheep point to the fact that urgent action needs to be taken to introduce new genetic material into the sheepfold of the University in order to shore up the genetic merit of the sheep. There's the danger of the allele (A) becoming fixed in the sheep population, and this might not be too advantageous if it does not confer any selective advantage in terms of productive, adaptive or reproductive abilities. Perhaps, the nature of the result was affected by the low number of animals sampled which is due mostly to mortality in the sheep population. Gene frequency for the allele A is higher than that for allele B, similar to the findings of Agaviezor *et al.* (2013); except in cattle where the allele AB was predominant. However, it corresponds with Hardy-Weinberg's equilibrium that P + Q = 1. No conclusion could be drawn however that sex has an effect on the differences observed in Hb types. This is based partly on the fact that not the same numbers of both sexes were sampled in the study. In conclusion, Hb polymorphism was observed in the animals studied with a higher frequency of HbAA observed except in cattle where HbAB was more predominant. The level of inbreeding is still relatively low in the samples studied (cattle and goat) while it will

soon set in the sheep population if urgent action to avert this is not instituted soon.

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Table 1: Genotype, gene frequency, inbreeding coefficient and expected heterozygosity and Chi-statistics of cattle

		Genotype frequency			Gene frequency	
	Number	AA	AB	BB	A	B
Male	9	1(0.11)	7(0.78)	1(0.11)	0.50	0.50
Female	16	3(0.18)	6(0.38)	7(0.44)	0.375	0.625
Total	25	4(0.16)	13(0.52)	8(0.32)	0.42	0.58
Chi-statistics						
Observed		4	13	8		
Expected		4.41	12.18	8.41		
Deviation		-0.41	0.82	-0.41		
Chi-square		0.038	0.055	0.020		0.113ns

Local inbreeding coefficient (F) = -0.00; Heterozygosity expected = 0.00; ns= not significant (p>0.05).

Table 2: Genotype, gene frequency, inbreeding coefficient and expected heterozygosity and Chi-statistics of goat

		Genotype frequency			Gene frequency	
	Number	AA	AB	BB	A	B
Male	11	9(0.82)	2(0.18)	0(0.00)	0.91	0.09
Female	19	15(0.79)	4(0.21)	0(0.00)	0.89	0.11
Total	30	24(0.80)	6(0.20)	0(0.00)	0.90	0.10
Chi-statistics						
Observed		24	6	0		
Expected		24.30	5.40	0.30		
Deviation		-0.30	0.60	-0.30		
Chi-square		0.004	0.067	0.30		0.37ns

Local inbreeding coefficient (F) = -0.00; Heterozygosity expected = 0.00; ns= not significant (p>0.05).

Table 3: Genotype, gene frequency, inbreeding coefficient and expected heterozygosity and Chi-statistics of sheep

		Genotype frequency			Gene frequency	
	Number	AA	AB	BB	A	B
Male	6	6(1.00)	0(0.00)	0(0.00)	1.00	0.00
Female	4	4(1.00)	0(0.00)	0(0.00)	1.00	0.00
Total	10	10(1.00)	0(0.00)	0(0.00)	1.00	0.00
Chi-statistics						
Observed		10.00	0.00	0.00		
Expected		10.00	0.00	0.00		
Deviation		0.00	0.00	0.00		
Chi-square		0.00	0.00	0.00		0.00ns

Local inbreeding coefficient (F) = -0.00; Heterozygosity expected = 0.00; ns= not significant (p>0.05).