

CARBONIC ANHYDRASE FREQUENCY AND POPULATION STABILITY AMONG BREEDS OF NIGERIAN GOAT.

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ABSTRACT

Using 900 goats of the three breeds in Nigeria from Borno, Sokoto and Ogun States with equal number across breed, blood was collected from each animal by means of jugular venipuncture and placed in heparinized tubes to prevent coagulation. It was then refrigerated at 8°C for two hours and thereafter carried into the laboratory. Carbonic anhydrase polymorphism from blood plasma and blood hemolysate were analysed by the method of starch gel electrophoresis using direct current electric source Multidrive XL. Gene, genotypic frequencies, allelic frequencies and genetic distance among the breeds were estimated for this locus. Carbonic anhydrase presented two alleles, Ca-S and Ca-F. The (Ca-F) was the predominant alleles in all the studied breeds. West African Dwarf breed recorded the highest frequency (0.9900) for (Ca-F) while the least value (0.9868) for (Ca-F) was observed in Red Sokoto goat. Considering the pattern of genotype within the sample population for carbonic anhydrase, it was observed that the average heterozygosity for all the breeds was 0.0000. This is a marker that the population has high level of homozygosity for carbonic anhydrase. UPMGA cluster showing relationship between populations at CA locus indicated similar distance value (0.0000) for the populations. It was recommended from observed result that the high level of homozygosity observed for this locus indicates that it is not a suitable candidate for selection and breeding purposes.

Keywords: Carbonic Anhydrase, Polymorphism, Nigerian goats.

INTRODUCTION

Biochemical polymorphism has a wide occurrence in nature. Gene controls biochemical polymorphism hitherto revealed has provoked much discussion with respect to its origin, maintenance and significance of heterozygosity. Reports of the impact of Carbonic anhydrase on morphometric traits are few; also morphological characteristics do not necessarily correspond to the genetic characteristics of blood protein and non-protein polymorphisms (Tsunoda *et al.*, 2010). Lemoset *al.* (1990) reported that the different phenotypes of this locus did not significantly influence reproduction, production and heat tolerance in Pintagueras cattle. In the Chicken, Das and Deb (2008) reported that no significant differences were detected between various biochemical types and economic traits. However the activity of CA has been positively correlated with egg shell thickness. Data on the

polymorphism of this blood enzyme and the advantages it confer are scarce, Akinyemi and Salako (2012) reported the preponderance of the S allele over the F allele in Nigeria indigenous sheep with values as high as 0.70 – 0.89 for the S allele. However, Ibeagha and Erhardt (2004) reported a fixation of S allele in Yankassa, Uda, and West African Dwarf sheep breeds and in Merino, East Friesian Milk and German Grey Heath sheep breeds.. The preponderance of the F gene across the breeds and low heterozygosity mean value may indicate extremely low variations in the polymorphic forms of this genes pointing to decreasing genetic variability in Nigeria indigenous goats for this locus, hence, may not be a suitable candidate to use in selection process irrespective of the advantage it may confer on performance and survival traits.

MATERIALS AND METHOD

The study was carried out in Borno, Sokoto and Ogun States. These states were selected because they are locations having close to pure breeds of the goats. Animals used for this study were sampled in the abattoir, of Borno, Sokoto and Ogun states when brought for slaughter either by the owner or by the slaughter man. It is believed that all animals find their way into the abattoir from villages and local markets, where they are kept in small numbers by local farmers; they are raised under the extensive system of management. A total of nine hundred (900) goats comprising of three hundred Sahel goats from Borno state, three hundred Red Sokoto goats from Sokoto state and three hundred West African Dwarf goats from Ogun state were used for the study. Each breed consisted of three hundred goats each, made up of fifty males and fifty females distributed in the following age groups <1, 1-2 and 2-3 years. Blood was collected from each animal by means of jugular venipuncture and placed in heparinized tubes to prevent coagulation. It was then refrigerated at 8°C for two hours and thereafter carried into the laboratory. polymorphic proteins from blood plasma and blood hemolysate were analysed by the method of starch gel electrophoresis using direct current electric source Multidrive XL.

Gene and genotypic frequencies were estimated using the Hardy-Weinberg Model which consists of two equations: One that calculates the allelic frequencies and one that calculate genotype frequencies. Since these involve frequencies, the rule of thumb is that both equations must add up to 1. Thus the equation used were:

1. $p + q = 1$, where $A = p$ and $q = B$
2. Gene (Allele) frequency
 $A = \text{Ratio AA} + \frac{1}{2} (\text{Ratio AB})$
 $B = \text{Ratio BB} + \frac{1}{2} (\text{Ratio AB})$
3. Genotype Frequency
 $P^2 + 2pq + q^2$, where $P^2 = A^2$ (or AA),
 $2pq = 2(AB)$ and $q^2 = B^2$ (or BB)
 $A^2 + 2AB + B^2$.

Gene frequency, genotypic frequency and Genetic distances among the breeds (estimated from gene frequencies) were calculated using Tools for Population Genetics Analyses

Software, Version 1.3 (Copyright, Mark P. Miller).

RESULTS AND DISCUSSIONS

Allele distributions between populations for carbonic anhydrase are shown in Table 1. Carbonic anhydrase presented two alleles, Ca-S and Ca-F. Carbonic anhydrase (Ca-F) is the predominant alleles in all the studied breeds. West African Dwarf breed recorded the highest frequency (0.9900) for (Ca-F) while the least value (0.9868) for (Ca-F) was observed in Red Sokoto goat. Considering the pattern of genotype within the sample population for carbonic anhydrase, it was observed that the average heterozygosity for all the breeds was 0.0000. This is a marker that the population has high level of homozygosity for carbonic anhydrase.

Table 2 shows the genotype distribution and average heterozygosity between populations at CA locus. Two carbonic anhydrase variants (CA-SS and FF) were observed. The highest frequency (0.9996, 0.9972, and 1.000) was observed in all the CA-FI variants for Red Sokoto, Sahel and WAD respectively. The test for hardy Weinberg equilibrium between population CA loci had significant ($P < 0.01$) differences among the goat breeds studied (Table 3). Table 4 shows the genetic distance between populations of CA locus. Red Sokoto vs Sahel and Sahel vs WAD have similar distance (0.0000) but Red Sokoto vs West African Dwarf shows slight variation (0.0001).

UPMGA cluster showing relationship between populations at CA locus was shown in Table 5. Similar distance value (0.0000) for was observed for both populations. Based on the consistency test, the estimated value of χ^2 is lower than the corresponding safety threshold value obtained from the data. This means that the research material is in genetic balance for carbonic anhydrase loci. The sample extracted of the population is consistent, in terms of gene and genotypic frequencies distribution of carbonic anhydrase, with the population as a whole being representative of Red Sokoto, West African Dwarf and Sahel goat populations. Carbonic anhydrase locus, CA^F was the most common in the three breeds occurring at a frequency of 0.98, 0.99 and 0.99 for Red Sokoto, Sahel and West African Dwarf respectively. This is in agreement

with the findings of Rebedea *et al.* (2005), Zanotti Casati *et al.* (1990) in three Asian breeds. CA^S was ever observed to be fixed in Yankassa, Uda, West African Dwarf sheep and goat breeds (Ibeagha-Awemu and Erhardt, 2004). The fixation CA^S is contradicted by the report of polymorphism CA^M (Missohou, 1999). CA^F has been reported by several authors (Nwacharo *et al.*, 2002) to be faster than CA^S.

CONCLUSION

There is a high degree of similarity in genetic relationship among the three breeds indicating a high rate of dilution of the breeds which may lead to loss of genetic resources in these breeds of goat. The high level of homozygosity observed for this locus indicates that it is not a suitable candidate for selection and breeding purposes.

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REFERENCES

- Akinyemi, M.O., Salako, A.E. (2012) Genetic relationship among Nigerian indigenous sheep populations using blood protein polymorphism. *AgriSci Tech*, 4(2): 107 – 112.
- Das, A.K. and Deb, R. (2008). Biochemical Polymorphism and its relation with some traits of importance in poultry. *Veterinary World*, 1(7): 220-22.
- Ibeagha – Awemu, E.M. and Erhardt, G. (2004). Genetic Variations between African German Sheep Breeds and Description of a new Variant Vitamin D-Binding protein. *Small Ruminant Research*, 55:33 – 43.
- Lemos, A.M., Lobo, R.B., Mortari, N and Moura-Duarte, F.A. (1990). Biochemical Blood Polymorphism in Pitangueiras Cattle and their effects on Reproductive, Productive and Heat tolerance Traits. *Brazil Journal of Genetics*. 13 (2): 293-303.
- Missohou, A. Nguyen, T.C., Sow, R. and Gueye, A. (1999). Blood Polymorphism in West African Breeds of Sheep. *Tropical Animal Health and Production*. 31: (3) 175-179.
- Nwacharo, J.M., Otieno, C.J., and Okeyo, A. N. (2002). Genetic Variation between indigenous Fat Tailed Sheep Populations in Kenya. *Small Ruminant Research*, 44:173-178.
- Rebedea, M., Ioanc, I., Colceri, D., Georgescu, S.E. and Costache, M. (2005) Study of the genetic polymorphism of some blood proteins in Romanian Black Spotted cattle. *ArchivaZootechnica* 8:176-182
- SAS (1990). Statistical Analysis System (SAS). Institute Inc. (1990). SAS/STAT User's guide version 6, 4th edition Vol. 2 SAS Inst-Inc. Cary, N.C 846.
- Tsunoda K, Chang H, Chang G, Sun W, Dorji T, Tshering G, (2010). Phylogeny of Local Sheep Breeds in East Asia, Focusing on the Bayanbulak Sheep in China and the Sipsu Sheep in Bhutan. *Biochemical Genetics*, 48, 1-12.
- Zanotti Casati, Gandini, G.C. and Leone, P. (1990). Genetic Variations and Distances of Five Italian Nature Sheep Breeds. *Animal Genetics*, 21:81-92.

Table 1: Allele distribution between populations for CA Locus

Population	Allele	CA frequency	Average allele Frequency
Red Sokoto	F	0.9868	0.2000
	S	0.0132	0.0000
Sahel	F	0.9900	0.0140
	S	0.0100	0.0060
WAD	F	0.9967	0.0110
	S	0.0033	0.1307

CA = Carbonic anhydrase; WAD=West African Dwarf

Table 2: Genotype distribution and average heterozygosity between populations at CA locus

Population	CA freq	Average allelic Frequency
Red Sokoto	FF	0.9996
	SS	0.0004
Sahel	FF	0.9972
	SS	0.0028
WAD	FF	1.0000
	SS	0.0000

CA=Carbonic anhydrase, WAD=West African Dwarf

Table 3: Test for Hardy-Weinberg Equilibrium between populations at CA locus

Population	CA locus	No. of obs	No. of Exp.	Chi ²	P-value	Df
Red Sokoto	FF	296	292.06	302.000	0.0000	1
	FS	0	7.89			
	SS	4	0.05			
Sahel	FF	297	293.03	299	0.00	1
	FS	0	6.94			
	SS	3	0.03			
WAD	FF	299	297.00	299	0.0000	1
	FS	0	1.99			
	SS	1	1.01			

CA = Carbonic anhydrase, WAD=West African Dwarf, Df= Degree of Freedom

Table 4: Genetic distance between populations on CA locus

Population	Distance	Identities
Red Sokotovs Sahel	0.0000	1.0000
Red Sokotovs WAD	0.0001	0.9999
Sahel vs WAD	0.0000	1.0000

CA = Carbonic anhydrase WAD=West African Dwarf

Table 5 UPMGA cluster showing relationship between populations at CA locus

Population	Distance	Includes population
1	0.0000	1 2
2	0.0000	1 2 3