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Influence of Blood Protein Polymorphism on Morphometric Indices of Nigerian Breeds of Goats

Shoyombo A.J.[1*], Alabi O.O.[1], Animashahun R.A.[1], Olawoye S.O.[1], Popoola M.A.[2], Musa A. A. [3], Yakubu H. [4], Williams M.E.[5], and Ogunniyi E.O [6]

[1]*Department of Animal Science, College of Agricultural Sciences, Landmark University Omu-Aran, Kwara State, Nigeria*
[2]*National Biotechnology Development Agency, Abuja Nigeria*
[3]*Department of Animal Science, Faculty of Agriculture, Kogi State University, Anyigba, Kogi State, Nigeria*
[4]*Department of Animal Science, Faculty of Agriculture, Ahmadu Bello, University, Zaria*
[5]*Department of Animal Science, Akwa Ibom State University, Obio Akpa Campus*
[6]*Department of Animal Production, School of Agricultural and Agricultural Technology, Federal University of Technology, Minna, Niger State*

[*]***Corresponding Author:*** shoyombo.ayoola@lmu.edu.ng*;* ***Phone No.:*** +234 (0)8036926455

Target Audience: Animal scientists, Breeders, Farmers

Abstract

The impact of Haemoglobin, Transferrin and Carbonic Anhydrase polymorphisms on age based morphological characters was studied among Red Sokoto, Sahel and West Africa Dwarf breeds of goat. A total of 900 goats equally distributed across three age groups and both gender were used for the study. Morphometric parameters were: Body weight(BW) Horn Length (HL); Ear Length (EL); Shoulder width (SW); Neck circumference (NC); Body Length(BL); Withers Height (WH); Heart Girth (HG); Paunch Girth (PG) and Tail Length (TL) respectively. Effects of blood protein polymorphisms on morphometric measurements were observed to vary with age especially with haemoglobin and transferrin. Also carbonic anhydrase influenced body mensuration characteristics of goats aged 1-2 years in BW, HL, EL, NC, BL and TL and only TL in 2-3 years old. The FF form of carbonic anhydrase was superior for most indices. The other proteins were not definitive in their effect across age groups.

Key words: Haemoglobin, Transferrin, Carbonic Anhydrase and morphometry, goat

Description of Problem

Indigenous sheep and goat breeds contribute over 98 percent of the total small ruminant population in Africa (1). These animals serve as 'bank' for the small farmer, a hedge against economic instability and hard times, and a source of year round employment (1). They are also important and secure forms of investment as they can be bought following good crop performance and sold following crop failures. They provide practical means of using vast areas of natural grasslands in regions where crop production is impracticable (2).

Goats have a high degree of heat tolerance and are resistant to many of the diseases prevailing in the tropics and have the ability to survive long periods of feed and water shortage. These properties are genetic and have been acquired by natural selection

over hundreds of generations.(8) The indigenous breeds found in Nigeria are, Red Sokoto, Sahel, and West African Dwarf (WAD) goats (2). These differ considerably in size, coat colour, horn length, etc. Their broad genetic variability enables them to survive under stressful environmental conditions including high disease incidence, poor nutrition which may increase animal susceptibility to disease, high temperature, and traditional husbandry system.

The first step in the characterization of local genetic resources is based on the knowledge of variation in the morphological traits (3). In recent years, analysis of genetic markers based on blood protein polymorphism (detected by the electrophoretic method) has become a tool for studying genetic differentiation among population or phylogenetic and evolutionary studies (4, 5, 6, 7). Studies on blood protein polymorphism have revealed that the phenotype of an individual with respect to these traits does not change throughout life except in extreme condition, for example haemoglobin switching, which can be identified by objective methods of analysis like electrophoresis (Van Vliet and Huisman, 1964). Blood groups and proteins have been widely used to assess genetic diversity (4, 5, 6, 7).

With the increasing emphasis on the need for planning of comparative evaluation studies, (8) suggested that the genetic relationship among breeds within each species should be determined, so that the breed could be grouped into sets that are genetically similar.

Thus an objective quantification of the magnitude of the genetic differences among a set of breeds can be obtained from allele frequency data for each breed. Although DNA – based technologies are now the method of choice, several alternative assays, such as protein/allozyme polymorphisms, remain tremendously useful, especially in developing countries like Nigeria, because of their utility, ease, cost, and amount of genetic information accessed simplicity of data interpretation. Paucity of information on the impact of Haemoglobin, Transferrin and Carbonic Anhydrase polymorphism on morphometric indices of Nigerian breeds of goats in available literatures has necessitated this study. Several workers have showed the impact of these blood proteins and their polymorphic forms on general production, reproduction and adaptability traits but none has detailed its impact on body morphometry. Since Knowing the body mass of small ruminants is very useful for good animal management, including understanding medication doses, adjusting feed supply, monitoring growth and choosing replacement males and females.

Materials and Methods

The study was carried out in Borno, Sokoto and Ogun States. These states were selected because they are locations having pure or close to pure breeds of the goats. Haematological studies and analysis were carried out in the Animal Breeding and Genetics laboratory of Animal Science Department, Faculty of Agriculture, University of Ibadan, Oyo State.

Experimental Animals and Management

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. Animals are brought into the abattoir from villages and local markets, where they are kept in small numbers by local farmers and raised under the extensive system of management.

Sampling Size and Sampling Structure

A total of nine hundred (900) goats comprised 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 were made up of fifty males and fifty females distributed in the following age groups <1, 1-2 and 2-3 years. These were evaluated for morphological, morphometric and biochemical polymorphism characteristics

Age Determination

The pairs of permanent incisors in the dentition of the goat were used to determine age.

Metric Variables

Weights of the animals were taken using a spring balance and Walk-in weighing scale. Flexible measuring tape was used to take the body measurements. During body measurement, animals were made to stand upright and restrained by two assistants in such a way that their heads, necks, and chest were stretched almost in a straight line. Each measurement was taken at least three times and the mean recorded to the nearest centimeter or kilogram.

Morphometric Measurements

Reference marks used for body measurement were done according to the methods of (9) were :

Withers Height (WH): Vertical distance from ground to the point of withers measured vertically from the ridge between the shoulder bones to the fore hoof.

Body Length (BL): Distance between points of shoulder to point of hip i.e the distance from the first thoracic vertebrae to base of tail. This is also described as the distance between in the most cranial palpable spinosus process of thoracic vertebrae and either sciatic tubers or distance between the tops of the pelvic bone.

Shoulder width (SW): Measured as the horizontal distance between the two shoulders or distance between the lateral tuberisities of the humeri which is also described as the widest point over the intraspinus muscle.

Tail Length (TL): Measured from the base of the tail to the tip (Coccygeal vertebrae)

Neck Circumference (NC): Taken as the circumference of the neck at the midpoint.

Heart Girth (HG): Measured as the circumference of the body at the narrowest point just behind the shoulder perpendicular to the circumference of the body, just in front of the hind leg perpendicular to the body axis.

Paunch Girth (PG): Measured as the circumference of the abdomen at its widest point.

Horn Length (HL): Measured as he average of the lengths of the two horns taken from the base to the tip. Average was used in order to make allowance for unexplained inequalities in horn length.

Age (A): the pair of permanent incisors in the dentition of the goat under examination was used to determine age. According to (9)

Scrotal Circumference (SC): Measured as the circumference of the scrotum taken at the mid-point.

Ear Length (EL): Measured as the distance from the base to the Zygomatic arch of the ear.

10mls of blood was collected from each animal by means of jugular venipuncture and placed in heparinized tubes to prevent coagulation. It was then refrigerated at 8^0C for two hours and thereafter carried into the laboratory and analyses were carried out as described in RIKEN Research (2006).

Statistical Analysis

The effects of blood protein polymorphism on linear measurements were estimated using the GLM procedure of the statistics analysis software (10) package. These were computed on the basis of interaction with age groups. Means were separated within age groups using Duncan multiple range test of (10).

Results and Discussion

The effect of Haemoglobin (Hb)

polymorphism on age related morphometric traits of Nigerian goats is shown in Table 1. Hb types (AA, AB, BB and AC) within ages less than a year and 1-2 years had no significant ($p>0.05$) effect on all measured morphometric characteristics except HG and PG in age < 1 year. HG and PG were significantly ($p<0.01$) influenced by Hb variants with the AB and AC having statistically similar but higher values than the homozygote BB and AA which were also similar. In goats aged 2-3 years, BL were statistically ($p=0.05$) similar among the AB and BB genotype (46.17 and 46.88) and differed from the AA a value of 42.48cm.

It was observed that only BL, HG and PG were significantly ($p<0.01$) influenced by polymorphic forms of haemoglobin, while BL was influenced at 2-3 years only and HG and PG at <1 year alone. The superior performance of the Hb type BB to the heterozygote AB and AC and homozygote AA genotypes reported by (12, 13) varied from what was obtained in this study and was contrary to the observation of (11) on WAD goats that showed that Hb variants influenced all morphometric traits measured. It is of note that goats, which are heterozygote for Hb variants were better performing either nominally or significantly than the homozygotes for BL, HG and PG. For live body weight at the earlier age groups, the same trend was obtained but was reversed at 2-3 years. There exist variations in literature reports on the effect of polymorphic forms of Hb on body traits: (12, 13) had reported that haemoglobin type had influence on performance of sheep and goats. (14) found no significant relationship between Hb type and body weight, body length, hearth girth and height at withers in Garole sheep. It should be noted that goats exhibit a very complex Hb polymorphism due to the presence of a number of allelic and non-allelic chains both in the alpha and beta globin systems (15), which may be responsible for the lack of clear pattern and accord in obtained results and literature reports on their impact on morphological traits.

The effect of Transferrin (TF) polymorphism on age related morphometric traits of Nigerian goats is shown in Table 2. Interactions between age and polymorphic forms of TF protein did not significantly ($p>0.05$) affect HL, EL, NC, BL and WH. BW, HG and PG were affected by this interaction for animals less than a year old with the AB, AC and BB genotypes being similar and having higher values which differed ($p<0.01$) from the AA genotype with the least value for all these traits. Age 1-2 years showed variations in HG with the Hb AA type having the highest (65.75cm) which differed from the AB, AC and BB Hb types which were similar. PG showed a trend of similarity of Hb AA, AC and BB (68.36, 65.20 and65.20respectively) which differed from Hb AB (64.39cm). Similarly, TL was similar in Hb AB, AC and BB (12.66, 12.59 and 12.80 respectively) groups which were significantly superior to AA (11.36).

Values for BW (Kg) at age 2-3 years were similar for AB, AC and BB Hb types (18.81, 19.85 and 18.56 respectively) and differed from AA (17.01) with the least weight. SW showed values which were similar for AA and AC types had similar SW (cm) values (19.52 and 20.91respectively) which were significantly different ($p<0.01$) from AB and BB types (18.09 and 18.12 respectively) having the least shoulder width. All other characterstics within age groups did not differ statistically among polymorphic forms of TF.

Not much literature reports on the influence of transferrin types on growth and morphometry of mammals exists, however, observed variation in traits of the present study with the AA AC and BB showing better performance over the AA at <1 year and 2-3 years differed from the report of (13) who found no significant effect of transferrin genotype on performance of Damascus goats.

However, smaller sample sizes of the study might have skewed observation towards non-significance.

Table 3 shows the effect of the interaction between age and carbonic anhydrase (CA) on morphometric traits of indigenous goats, two forms of polymorphs labelled FF and SS were observed. SW, WH, HG and PG were not significantly ($p>0.05$) influenced by the interaction. Also, significant differences were not recorded for all traits in the less than 1 age bracket and was only recorded in TL for age 2-3 years, where the SS genotype had the longest tail length (17.00) compared to the FF (12.76). BW, HL, NC, BL and TL were significantly influenced with the FF having higher values for these traits compared to the SS at 1-2 years of age. EL however, showed the superiority of the SS (16.00) to the FF (11.98) within this age group.

Reports of the impact of Carbonic anhydrase on morphometric traits are few in extant literature. Moreover, morphological characteristics do not necessarily correspond to the genetic characteristics of blood protein and non-protein polymorphisms (Tsunoda et al. 2010). This enzyme performs purely a buffering role in carbon, carbonate and pH regulation in the living cells. Findings obtained in this study however, revealed that it significantly influenced body mensuration characteristics of goats aged 1-2 years in BW, HL, EL, NC, BL and TL and only TL at 2-3 years old.

Conclusion and Applications

1. The influence of blood protein polymorphism factors on morphometric measurements were observed to vary with age. These points to the need to carry out selections based on these polymorphs with age as a threshold factor in mind. There is no clear cut distinction based on age established for transferrin impact. However, the heterozygote Hb forms were better than the homozygote across all ages for most measured traits. It can thus be stated that selection of heterozygote animals for transferrin protein will yield animals with moderate to high growth performance. The FF form of Carbonic Anhydrase was superior for most indices and could serve as a potential tool for selection in growth and adaptation studies especially in environments were acid base balance is significantly influenced such as when animals travel long distance or during pre-slaughter stress which serves to disrupt body pH balance.

2. Further studies on CA locus and the advantages it confers using other methods of determination and analysis is encouraged so as not to relegate to the background what may be a potential marker in goat breeding and genetics.

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Table 1: Effect of haemoglobin polymorphism on age related morphometric traits of Nigerian goats

Age	*<1 year*				*1-2 years*			*2-3 years*				
Hb	*AA*	*AB*	*AC*	*BB*	*AA*	*AB*	*BB*	*AA*	*AB*	*BB*	*SEM*	*LOS*
BW	13.48	13.59	13.25	12.98	13.35	14.04	13.32	19.09	17.93	19.86	1.05	**
HL	6.23	6.07	5.00	5.21	6.73	6.62	7.00	7.12	6.94	7.83	0.70	**
EL	10.46	9.91	9.50	9.95	12.03	12.04	12.10	11.43	12.14	12.33	0.61	**
SW	15.04	13.62	13.00	12.84	13.58	13.00	13.65	19.80	19.27	20.18	1.27	**
NC	23.63	22.93	21.50	22.94	25.56	27.05	25.50	24.05	24.74	25.23	1.08	**
BL	42.71	43.23	39.50	40.68	48.54	49.68	48.48	42.48b	46.17a	46.90a	2.21	**
WH	52.80	51.82	54.50	51.26	55.05	55.56	53.50	57.07	58.68	58.80	2.53	ns
HG	52.39b	58.53a	56.50a	54.56b	62.41	63.31	63.16	61.79	61.34	60.25	1.67	ns
PG	54.46b	60.62a	58.15a	56.60b	64.61	65.66	65.44	64.32	63.75	62.70	1.80	ns
TL	12.33	11.84	12.50	11.68	12.41	12.37	12.71	12.11	13.07	13.01	0.58	ns

Keys: BW: Body weight; HL: Horn Length; EL: Ear Length; SW: Shoulder width; NC: Neck circumference; BL: Body Length; WH: Wither Height; HG: Heart Girth; PG: Pouch Girth and TL: Tail Length **p< 0.01.

Table 2: Effect of Transferrin Polymorphism on Age related Morphometric Traits of Nigerian Goats

	<1 year					*1-2years*				*2-3 years*				
TF	*AA*	*AB*	*AC*	*BB*	*AA*	*AB*	*AC*	*BB*	*AA*	*AB*	*AC*	*BB*	*SEM*	*LOS*
BW	12.47b	13.76a	12.95a	14.93a	12.49	13.28	13.52	14.79	17.01b	18.81a	19.85a	18.56a	1.05	**
HL	5.68	5.04	5.92	6.18	7.25	6.38	6.77	7.32	7.08	7.33	7.57	6.96	0.70	ns
EL	10.31	9.91	9.93	10.36	12.11	11.36	12.09	12.85	11.66	12.28	12.21	11.85	0.61	ns
SW	14.72	14.54	12.69	13.92	12.63	13.39	13.53	13.46	19.52a	18.09b	20.91a	18.12b	1.27	**
NC	23.42	22.93	22.65	24.53	26.11	24.45	26.40	26.27	24.49	23.77	25.20	25.21	1.08	ns
BL	42.53	41.59	42.07	41.35	50.10	48.54	48.10	52.23	47.57	44.57	44.76	48.05	2.21	ns
WH	50.56	52.13	51.89	52.83	52.39	52.83	54.96	56.18	58.91	58.05	58.24	58.91	2.53	ns
HG	53.06b	55.26a	55.58a	58.30a	65.75a	62.03b	62.95b	63.08b	61.79	60.82	60.27	62.91	1.67	**
PG	54.96b	57.30a	57.71a	60.32a	68.36a	64.39b	65.20a	65.20a	63.94	63.40	62.70	65.57	1.80	**
TL	11.88	11.70	11.88	12.30	11.36b	12.66a	12.59a	12.80a	12.92	12.48	12.97	12.46	0.58	**

Keys: BW: Body weight; HL: Horn Length; EL: Ear Length; SW: Shoulder width; NC: Neck circumference; BL: Body Length; WH: Wither Height; HG: Heart Girth; PG: Pouch Girth and TL: Tail Length **p< 0.01.

Table 3:Effect of Carbonic Anhydrase Polymorphism on Age related Morphometric Traits of Nigerian Goats

Age	*<1 year*		*1-2years*		*2-3 years*			
EA	*FF*	*SS*	*FF*	*SS*	*FF*	*SS*	*SEM*	*LOS*
BW	13.28	14.00	13.60a	11.50b	19.07	20.00	1.48	*
HL	5.74	4.50	6.88a	3.50b	7.38	7.00	1.00	*
EL	10.05	9.50	11.98b	16.00a	12.12	11.00	0.86	*
SW	13.60	13.00	13.39	15.00	19.77	21.30	1.80	ns
NE	23.06	23.25	26.15a	19.00b	24.80	23.00	1.53	*
BL	41.95	41.50	49.24a	31.00b	45.48	44.80	3.13	*
WH	51.92	48.00	54.65	48.50	58.31	64.00	3.58	ns
HG	55.39	57.50	63.00	64.50	60.93	57.00	2.36	ns
PG	57.45	59.50	65.29	66.45	63.39	59.10	2.55	ns
TL	11.90	11.50	12.58a	10.00b	12.76b	17.00a	0.82	*

Keys: BW: Body weight; HL: Horn Length; EL: Ear Length; SW: Shoulder width; NC: Neck circumference; BL: Body Length; WH: Wither Height; HG: Heart Girth; PG: Pouch Girth and TL: Tail Length *p< 0.05.