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Haemoglobin types and their effects on morphometric traits of indigenous cattle, sheep and goats in Nigeria

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Abstract

This study focused on polymorphisms of haemoglobin in some indigenous ruminants. Blood samples were collected from a total of 2400 ruminants (600 cattle, 900 goats and 900 sheep) and analyzed. Body Weight (BW) and Nine linear body measurements viz: Height at withers (HW), Body length (BL), Heart girth (HG), Face length (FL), Neck length (NL), Neck width (NW), Rump width (RW), Ear length (EL), Tail length (TL) and shoulder width (SW) were measured on each animal prior to blood sample collection. The results revealed that animals with heterozygotes genotype Hb AB had higher values for body weight (313.42 kg), body length (158.23 cm), shoulder width (28.21 cm) and heart girth (150.39 cm) in cattle. In goats, individuals with Hb BB and Hb AB had similar heart girth (69.33 and 66.16 cm), body weight (21.08 and 20.92 kg), and shoulder width (10.43 and 10.23 cm), though they were better than those with Hb AA genotype. In conclusion, while Hb AA is an adaptation genotype in sheep, Hb AB is the genotype of choice for both adaptation and meat traits in cattle and goats.

Keywords: cattle, sheep, goats, haemoglobin, body, measurements

Introduction

Ruminants have served and will continue to serve a valuable role in sustainable agricultural system. They are particularly useful in converting vast renewable resources from rangeland, pasture, and crop residues or other byproducts in to food edible for humans. Also, nutrient in byproducts are utilized and do not become waste disposal problem. These are converted into high quality foods for human consumption (Oltjen and Becket., 1996).

Haemoglobin is historically important for their parts in the demonstration of the relationship between genetic information and protein structure (Agaviezor *et al.,* 2013). Haemoglobin polymorphism is reported to have variants and these variants have been reported to be associated with environmental adaptability (Peters *et al.,* 2004). Several studies in ruminants have also linked different haemoglobin types to production traits and differences in frequency of genes among locations (Akinyemi and Salako, 2010; Al-Samarrae and Younis, 2011). Macmanus *et al.* (2002) reported that genotype Hb AA were significantly lighter in weight than AB and BB in cattle. On the other hand, Sam *et al.* (2012) reported that Hb AA was superior to other genotypes in body conformation traits of goats in North Western Nigeria. Similarly, Yakubu *et al*. (2014) observed a higher body weight and heart girth of goats with Hb AA genotypes than AB and BB in North Central Nigeria. Thus, this study was aimed at investigating the relationship between haemoglobin polymorphism and morphometric traits in indigenous cattle sheep and goats in Nigeria.

Materials and methods

Study area

The study was carried out in Maiduguri, Borno state, located on latitudes 10 and 14^0N and longitudes 11 and 14^0N and altitudes of 345m above sea level. It falls within the sudan-savannah (semi-arid) zone (BOSHIC, 2007).

Experimental animals and their managements

A total of 2400 blood samples were

collected from nine hundred (900) cattle, (900) nine hundred (900) sheep and goats of different breeds (three breeds per species), and sexes. The following body measurements were taken on each of the animals examined using flexible tape (cm), vernier caliper and weighing balance (kg) as described by Yakubu et al. (2010).

The weights of small ruminants were taken by putting the animals inside sack and hanging it on the weighing balance and the reading taken, whereas for cattle, weighing bridge was used. Height at wither was measured as the distance from the ground to the points of the withers. The distance from the occipital protuberance to the base of the tail was measured as body length while heart girth was taken as the narrowest circumference of the chest immediately posterior to the fore legs. Face length was measured as the distance between the horn to the lower lip and neck length, from the occipital bone to the base of hump. Neck width was taken as the distance between the two sides of the neck at its middle and rump width as the distance between the two tuber coxae. Ear length is the distance from the point of attachment to tip of the ear and tail length was measured from the base of the tail to the end of the coccygeal vertebrae. The distance between the processes on the left and right shoulder blades was measured as the shoulder width.

Blood samples were collected through jugular venipuncture in to a bottle that contained EDTA. The red cells were separated, washed in saline solution and lysed with distilled water. Haemoglobin was typed using cellulose acetate electrophoresis as described by Imumorin *et al.* (1999). The identification of the haemoglobin types was achieved in accordance with the migration speed of the light spots on the electrophoretic substratum. Direct gene counting method was used to score Hb bands based on the separation of Hb variants. Haemoglobin typing was carried out at the Animal Science Laboratory University of Maiduguri, Borno State, Nigeria.

Statistical analysis

Influence of haemoglobin type on the morphometric characteristics was analyzed using one way Analysis of Variance in the Statistics 9.0 software. The model used was:

$Y_{ijk}=A_o+B_i+E_{ijk}$

Where: Y_{ij} = j^{th} Observation belonging to i^{th} haemoglobin type.

μ_o = Overall mean

B_i = Fixed effect of haemoglobin type

e_{ij} = Random error associated with record which is assumed to be random, independent and normally distributed.

Results and discussion

Relationship between haemoglobin polymorphism and morphometric characteristics

The least squares means on the relationship between haemoglobin polymorphism and morphometric characteristics of cattle are presented in Table 1. The effect of haemoglobin type was significant ($p<0.05$) for only body length, heart girth, body weight, shoulder width, tail length and ear length where Hb AB was superior to both Hb BB and Hb AA. Similarly, Macmanus *et al.* (2002) confirmed that animals with genotype Hb AA were significantly lighter than those of Hb AB and Hb BB in cattle. In the same vein, Chineke *et al.* (2007) reported that, Hb AB rabbits performed better than Hb AA in individual kit weight and average litter weight at weaning and post weaning ages of 35 and 56 days. In contrast, Kumaran *et al*. (1984) observed no significant difference between heamoglobin type and body weight in cattle at birth, 12 and 14 weeks and age at first calving.

Table 1: Influence of haemoglobin type on morphometric characteristics of cattle

Parameters		Genotype			Grand Mean
		AA	AB	BB	
BL	*	156.83±3.33^{c}	158.23±1.39^{a}	157.31±1.38^{b}	157.46
FL	NS	45.20±1.05^{a}	44.47±0.44^{a}	44.15±0.43^{a}	44.61
HG	*	149.04±3.09^{b}	150.39±1.29^{a}	149.44±1.28^{ab}	149.62
HW	NS	126.99±3.58^{a}	133.09±1.49^{a}	129.31±1.49^{a}	129.79
NL	NS	36.35±1.37^{a}	37.34±0.57^{a}	36.93±0.57^{a}	36.87
RW	NS	40.48±2.5^{a}	39.08±1.07^{a}	39.81±1.07^{a}	39.79
EL	*	20.92±0.43^{c}	21.96±0.18^{b}	22.55±0.17^{a}	21.81
BW	*	312.64±14.93^{b}	313.42±6.23^{a}	312.95±6.21^{ab}	131.01
NW	NS	15.08±0.50^{a}	15.63±0.21^{a}	15.58±0.21^{a}	15.43
SW	*	26.20±0.75^{b}	28.21±0.31^{a}	27.70±0.31^{ab}	27.37
TL	*	71.83±1.86^{b}	72.16±0.77^{ab}	72.63±0.77^{a}	72.35

a,b means in the same column with different superscripts are significantly different ($p<0.05$)
NS not significant ($p>0.05$) BL: Body length, FL: Facial length, HG: heart girth, HW: height at wither, NL: neck length, RW: Rumb width, EL: Ear length, BW: Body weight, NW: Neck width SW: Shoulder width, TL: Tail length.

In this study, animals that were superior in body weight and other traits like body length and heart girth commonly used in predicting body weight were of Hb AB genotype. This genotype (Hb AB) can therefore be considered the best for beef production.

The least squares means on the influence of heamoglobin polymorphism on morphometric characteristics of sheep are presented in Table 2. No significant relationships were observed between haemoglobin type and most of the body characteristics (body length, facial length, heart girth, height at withers, rump width, body weight, shoulder width and tail length). This is in concordance with the study of Yaman *et al.* (1986) who also did not observed any significant effect of haemoglobin types on either weaning weight or body weight at the end of three months fattening period. However, significant ($p<0.05$) effect observed in favour of Hb BB genotype on neck length, ear length and neck width, agrees with the view of Barowicz and Pacek (1984) that Hb BB ewes were superior in body weight, wool length and fleece weight than Hb AA and AB. Significant relationship observed between haemoglobin type and traits like neck length, ear length and neck width are of lesser importance because these parameters cannot predict body weight.

The influence of haemoglobin polymorphism on morphometric characteristics of goats is presented in Table 3. No significant differences were observed between haemoglobin genotype and morphometric characteristics like body length, face length, rump width, height at wither, ear length, neck width, and tail length. On the other hand, individual with Hb BB genotype were significantly ($p<0.05$) superior in body weight, heart girth, neck length and shoulder widths than Hb AB and Hb AA. This agrees with the reports of Sam *et al.* (2012) and Yakubu *et al.* (2014), who observed no significant relationship between most of the body parameters they measured and haemoglobin polymorphism except in heart girth and body weight. It also agrees with the report of Abdallah *et al.* (2012) who observed that lambs with Hb BB type had higher body weights at birth, weaning, 6 months, 9 months, yearling and daily gain than those with Hb AA and Hb AB in Rahmany sheep. Barowics and Pacek (1984) also reported that Hb B type is associated with productive performance. Since the effects of Hb BB and Hb AB were similar with respect to important traits like heart girth, body weight and height at wither. Hb AB can be the genotype of interest in goats of Maiduguri.

Table 2: Influence of haemoglobin polymorphism on morphometric characteristics of sheep

Parameters		Genotype AA	BB	Grand mean
BL	NS	94.606±0.47[a]	92.830±1.38[a]	93.718
FL	NS	20.977±0.08[a]	21.000±0.24[a]	20.989
HG	NS	83.261±0.28[a]	83.830±0.83[a]	83.546
HW	NS	79.989±0.40[a]	78.298±1.19[a]	79.143
NL	*	24.326±0.19[b]	25.734±0.56[a]	25.030
RW	NS	14.609±0.08[a]	14.301±0.25[a]	14.455
EL	*	20.129±0.09[a]	19.421±0.27[b]	19.775
BW	NS	39.114±0.18[a]	38.755±0.54[a]	38.935
NW	*	6.0104±0.09[b]	7.0457±0.27[a]	6.5281
SW	NS	13.549±0.31[a]	12.676±0.92[a]	13.111
TL	NS	39.958±0.24[a]	39.326±0.71[a]	39.642

a,b means in the same column with different superscripts are significantly different ($p<0.05$)
NS not significant ($p>0.05$)
BL: Body length, FL: Facial length, HG: heart girth, HW: height at wither, NL: neck length, RW: Rumb width, EL: Ear length, BW: Body weight, NW: Neck width SW: Shoulder width, TL: Tail length.

Table 3: Influence of haemoglobin type on morphometric characteristics of goats

Parameters		Genotype AA	AB	BB	Grand Mean
BL	NS	77.2343±0.52[a]	78.293±0.36[a]	78.222±0.77[a]	77.916
FL	NS	17.054±0.12[a]	17.250±0.08[a]	17.119±0.18[a]	17.141
HG	*	66.798±0.51[b]	67.796±0.36[ab]	69.332±0.76[a]	67.972
HW	NS	66.467±0.36[a]	66.166±0.25[a]	66.10±0.54[a]	66.414
RW	NS	11.375±0.11[a]	11.587±0.08[a]	11.736±0.17[a]	11.566
NL	*	20.860±0.30[a]	19.594±0.21[b]	19.763±0.44[b]	20.072
EL	NS	16.241±0.14[a]	16.288±0.10[a]	16.068±0.21[a]	16.199
BW	*	20.488±0.21[b]	20.927±0.15[ab]	21.081±0.31[a]	20.819
NW	NS	5.326±0.05[a]	5.401±0.03[a]	5.431±0.08[a]	5.386
SW	*	9.734±0.16[b]	10.230±0.11[ab]	10.432±0.24[a]	10.132
TL	NS	13.392±0.14[a]	13.073±0.10[a]	13.267±0.21[a]	13.244

a,b means in the same column with different superscripts are significantly different ($p<0.05$)
NS not significant ($p>0.05$)
BL: Body length, FL: Facial length, HG: heart girth, HW: height at wither, NL: neck length, RW: Rumb width, EL: Ear length, BW: Body weight, NW: Neck width SW: Shoulder width, TL: Tail length.

Conclusion

The study showed that, there is a relationship between genotype and body conformation traits which revealed that heterozygote Hb AB is the genotype of choice for meat in cattle and goats though no relationship was observed for sheep.

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