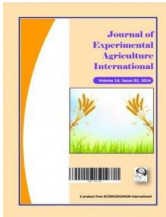

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Effect of Heamoglobin and Potassium Polymorphism on Milk Production Traits in Goats

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Authors' contributions

This work was carried out in collaboration between both authors. Author IMS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author GNA managed the analyses of the study and also managed the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

A study was conducted to determine the effect of hemoglobin (Hb-type) and potassium (k-type) types on milk yield characteristics of Agropastoral goats. Records were obtained from a total of 250 does over a period of one year. The milk yield characteristics were initial milk yield (IY), average daily yield (ADY), initial yield (IY), peak day (PD), peak yield (PY), and lactation length (LL).The data generated from the study were analyzed using General Linear Model (GLM) procedure of SAS and Duncan Multiple Range Test (DMRT) procedure of SAS was used to separate the significant means. Hb-type significantly influenced some milk yield characteristics of the goats. Does with HbAA and HbAB were similar and significantly had ($P<0.05$) higher ADY and PY than HbBB. But there were no significant ($p>0.05$) differences in milk yield characteristics when potassium types were consider, however animals of high potassium (HK) types were found to be favoured by natural selection in the region over low potassium (LK). It was concluded that, potassium and heamoglobin

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types can be explored to help in improving milk production traits of indigenous goats by identifying the heamoglobin and potassium types that are more adaptive to a particular environment and has a comparative advantage in milk yield characteristics.

Keywords: Heamoglobin types; potassium types; milk production traits; Goats.

1. INTRODUCTION

Nigeria is endowed with large numbers of small ruminants which are yet to be fully explored for milk production. Goats are the largest in number among ruminant livestock, totaling about 53.8 million [1]. Goats are predominantly owned by the rural households and ownership is spread across all human age groups and sexes [2]. They are kept mostly for meat, the milk is rarely used, but the awareness on importance of goat milk is rapidly gaining attention. Apart from the ease of management and high prolification, goats have high potential for milk production [3]. Genetic variations within population of animals are of great importance to breeders. This is because the amount of genetic variation seen in a population of animals determines the magnitude of genetic improvement that can be achieved within the species [4,5]. Electrophoresis techniques have been used to detect polymorphism at protein and enzyme loci for measurement of variation [4]. Information obtained from this type of study have been useful as genetic markers for important economic traits and aids significantly in selection of superior animals for breeding purposes [4,5]. Blood biochemical polymorphism in domestic animals is used for parentage determination and indirect selection criteria for livestock species [6]. Blood polymorphism studies have been conducted extensively to identify biodiversity among livestock animals. [7,8,9,10]. Potassium ion is an essential in regulating osmotic balance between cells and the extracellular fluid [11,12]. [13] explained that potassium concentration in red cells of small ruminant are controlled by two alleles on a single gene, and they are allele K^H which is responsible for high potassium concentration in blood while allele K^L is responsible for low potassium concentration. K^L is completely dominant over K^H. [14] identified the HbAA and HbBB as single bands with HbAA being the fastest single band towards the anode during electrophoresis while HbBB was the slowest. The HbAB, however, was identified as a double band having both the fast moving AA and slow moving BB. [4,15] also reported similar haemoglobin types, but occurrences for each haemoglobin type vary from location to location.

It has been evidenced by several researchers that heamoglobin and erythrocyte potassium types in domestic animals are associated with some production/reproduction traits such as milk production, body weight, mortality rate, fleece weight, fertility and adaptation capacity [7,16,17,18,19]. Moreever heamoglobin and potassium can be determined easily at the postnatal period of young animals and these components are not affected by the environmental factors, and can reduce the time of rearing inferior animals before selection. The relationships between blood polymorphism and milk production traits could be used as indirect selection criteria to improve animal production levels. In Nigeria, a lot of researches have been done to evaluate milk yield characteristics of goats in terms of genetic and non-genetic factors, but there are limited information on relationship between milk yield characteristics with heamoglobin and potassium polymorphism. Therefore, the objective of this study was to investigate the relationship between these heamoglobin and potassium polymorphic genes and milk production traits.

2. MATERIALS AND METHODS

2.1 Study Area

The Study was carried out in two States within the North-West Nigeria. The States were Jigawa and Katsina State. Katsina lies between latitude 13°01’ North of the equator and longitude 07°41’ East of Greenwich meridian. It is situated at an altitude of 464 m (1525 ft) above sea level and is located in the Sudan savannah agro-ecological zone. It has two distinct seasons. The wet season which lasts from June and ends September. The dry season is experienced between October and May. Mean annual rainfall is about 780 mm. Katsina State is hot for most parts of the year, even during the wet season. Mean annual temperatures range between 19° in the cold dry season to 38°, with the highest temperatures normally experienced in April and

May, just before the rains [20]. Jigawa State falls within latitude 11°-13°N and Longitude 8-10°E. Temperatures can go as low as single digits in the nights in most of the Northern parts during the Harmattan season (December to February), and could also rise as high as 45 degrees during the hot season (April to June). There are two seasons in Jigawa State namely: rainy and dry seasons with the dry season lasting from November to May and the rainy season lasting between June and October, [21].

2.2 The Animals and Management

The goats were under the agropastoral management. The animals were taken out to graze every morning from 8.00 am to 5.00 pm by children and were penned at night in small open sided shades by tethering. Before setting out for grazing every morning, the goats were given water and supplement which included groundnut haulms, bean haulms, bean pods and dry grasses containing 53.7% and 10.5% TDN and CP respectively. The young goats were left to suckle their dams freely for the first 6 days postpartum to enable them take advantage of colostrums.

2.3 The Measurements

A total of 250 does (whose parities were between 1-6 and average body weight of 28.84 kg) were used for this study. All milk measurements commenced from day 7 postpartum and were taken till the milk yield was less than 100 ml.

During milking, lactating does were kept calm by providing supplements in a feeder for them. The quantity of milk available per doe per test day was measured using graduated plastic beakers. Milk yield was determined twice a week.

The young ones were separated from their dams at 18.00 hours on the evening proceeding the day of milking. On the test day, the two halves of the udder of each lactating doe were hand-milked for all herds from 06.00 to 08.00 hours and the milk yield was recorded to the nearest gram. The average of the total volume of milk collected for the two test days was taken as the average daily yield of the doe for that week. Milk recording was terminated at the point where a doe was unable to produce 100 ml and above.

Milk yield characteristics were measured as follows:

Average Daily Yield (ADY): - As average of all test day yields within the period milked.
Initial Yield (IY): - As milk yield at day 7 postpartum
Total Yield (TY): - As milk production during the study before the production drop**s** below 100 ml.
Peak Yield (PY): - As the yield with the highest test day yield.
Peak day (PD): - As the day with the highest yield.
Lactation Length (LL): - As the period during which the doe was milk.

2.4 Blood Collection and Preparation

5 ml of blood was collected from each of the sampled animals by jugular venipuncture, using needle and syringe into test tube containing Ethylene Diamine Tetra Acetic acid (EDTA) as anticoagulant and properly labeled and samples were taken to hematological laboratory of Bayero University Kano Teaching Hospital, Kano. The blood samples were then washed with normal saline and haemolysed with distilled water to release the haemoglobin. The supernatant was removed after centrifuging at 3000 rpm for 5 min and the sample haemoglobin stored until ready for electrophoresis. Cellulose acetate paper strip was used to separate the globin fractions. Electrophoresis was carried out in Shandon electrophoresis tank on cellulose acetate strips 34.5 x 150 with 0.26 M Tris buffer (pH 9.1) at the anode and cathode. The strips were run for 5 minutes at a constant voltage of 250 v until a clear separation was observed. Interpretations were made based on the relative mobility of the haemoglobin bands towards the anode. The genotype that migrated faster was labeled HbAA; the slow moving fraction was identified as HbBB. The double band, consisting of both fast and slow band; was labeled HbAB as described by [15,22]. The potassium concentrations in the blood were determined by colorimetric method using spectrophotometer. The erythrocyte potassium below or equals to 13.00 mmol/l was labeled low potassium, while the erythrocyte potassium above 13.00 mmol/l was tacked high potassium as describe by [23].

2.5 Statistical Analysis

The data generated from the study were analysed using General Linear Model (GLM) procedure of SAS [24]. The model incorporated Hb-type and K-type, as fixed factors while milk yield characteristics were the dependent variables. Duncan Multiple Range Test (DMRT)

Table 1. Mean Values (± se) of milk yield characteristics of goats according to heamoglobin types

Milk yield characteristics	HbAA	HbAB	HbBB	LOS
ADY(g)	253.70 ± 2.92[a]	257.00 ± 2.76[a]	240.55 ± 5.55[b]	*
TY(kg)	30.19 ± 0.59	30.32 ± 0.58	27.32 ± 13.00	ns
IY(g)	241.00 ± 4.93	244.42 ± 0.58	247.43 ± 9.20	ns
PD(days)	34.60 ± 0.69	32.88 ± 0.67	32.79 ± 1.27	ns
PY(g)	359.72 ± 5.66[b]	385.00 ± 38.15[a]	350.17 ± 7.89[b]	*
LL(days)	119.00± 1.57	118.73 ± 1.54	113.60 ± 2.99	Ns
No of observation	108	112	30	

*Values bearing different superscript at the same row differ significantly (P<0.05); *=P<0.05; ns = non-significant, ADY = Average Daily Yield, TY = Total Yield, IY=Initial Yield, PD = Peak Day, PY =Peak Yield, LL = Lactation Length*

procedure of SAS was used to separate the significant means. The linear model was as follows:

$$Y_{ij} = \mu + K_i + H_j + E_i$$

Where

- Y_{ij} = Measurement on traits
- μ = Overall mean
- Kj = Effect of potassium types (K = Lk, Hk)
- H_j = Effect of hemoglobin types (k = AA, AB, BB)
- E_{ij} = Random error effect

3. RESULTS

3.1 Heamoglobin Types and Their Relationship with Milk Yield Characteristics in Goats

The influence of Hb type on milk yield characteristics is presented in Table 1. The results shows that only ADY and PY were significantly (P<0.05) influenced by Hb types. Does with HbAA and HbAB were similar and significantly had (P<0.05) higher ADY and PY than HbBB. All other milk yield characteristics followed the same trend, though not significant.

3.2 Potassium Types and Their Relationship with Milk Yield Characteristics in Goats

The effect of potassium types on Milk yield characteristics is shown in Table 2. The results indicate that K-types had no significant (p>0.05) influence on milk yield characteristics. Although there were no significant (p>0.05) difference, animals with HK performed better in all the milk yield trait evaluated (Table 2).

4. DISCUSSION

The observed variation in milk yield characteristics (ADY and PY) with Hb-type had earlier been reported in other species. [25,26] in cow and ewe, respectively observed that HbAB was superior to both HbAA and HbBB in milk yield. However, [27] observed that cows with HbAA were superior to HbAB and HbBB in some milk yield characteristics in cows studied in Zaria. On the contrary, [28] reported that there were no differences in the milk production of ewes with different haemoglobin genotypes. The variation in the performance of the animals due to differences in Hb-types at different location suggests that different Hb-types may have selective advantage in different geographical region [29]. The observation in this study suggests that in the study area, Jigawa and Katsina states indigenous goats with HbAA and HbAB have high potential for milk yield than those with HbBB.

The observed non-significant influence of potassium types on milk yield characteristics in this study is contrary to the reports of [30] which reported significant influence of potassium types on total milk yield of Awassi sheep, with LK being superior to HK. Limited literature is available on the influence of potassium types and milk yield characteristics in small ruminants. However, a careful study of the means of milk yield characteristics according to potassium types shows that HK, though not significant, were superior to the LK type animals. This could be attributed to association of this gene with aspect of fitness, with animals of HK types being favoured by natural selection in the studied region. Large sample size is required to confirm the findings of this work as this will remove bias and tendency for results to skew towards one direction.

Table 2. Mean values (±se) of milk yield characteristics of goats according to potassium types

Milk yield characteristics	HK	LK
ADY(g)	248.41± 2.01	247.19±4.69
TY(kg)	29.65 ± 0.59	29.25 ± 0.99
IY(g)	244.36±3.39	239.33±7.90
PD(days)	33.09±0.47	32.80 ± 1.11
PY(g)	360.41±4.05	349.64 ± 9.43
LL(days)	118.32±1.12	117.87 ± 2.62
No of observation	211	39

ADY = Average Daily Yield, TY = Total Yield, IY = Initial Yield, PD = Peak Day, PY =Peak Yield, LL = Lactation Length, K-type = potassium types, HK = high potassium, LK = low potassium

5. CONCLUSION

The findings in this work did not give strong reasons to conclude that potassium polymorphism could be used as selection criteria for milk production in goats. However, the non-significant variation of most milk yield characteristics with haemoglobin and potassium genotypes suggests that haemoglobin and potassium genotypes are more of adaptive traits than productive traits. Therefore, potassium and haemoglobin which are genetic markers can be explored to help in improving milk production traits of the indigenous goat breed by identifying the potassium and heamoglobin types that are more adaptive to a particular environment and has a comparative advantage in milk yield characteristics.

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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