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The Combined Effects of Haemoglobin, Potassium Types and Coat Colour on Milk Yield Characteristics in Goats

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Authors' contributions

This work was carried out in collaboration between all authors. Author IMS designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors IMS and UAU managed the analyses of the study. Authors JSE and GDE managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The objective of this study was to determine the effect of interaction between haemoglobin type, potassium type and coat colour on milk yield characteristics in goat. A total of 250 agropastoral goats were studied for milk yield characteristics which included average daily yield (ADY), total yield (TY), initial yield (IY), peak yield (PY) and lactation length (LL). Blood biochemical polymorphism (haemoglobin type and potassium type), as well as coat colour of agropastoral goats, were evaluated. The combined effects of haemoglobin type, potassium type as well as coat colour on milk yield characteristics were analysed using one-way analysis of variance. Animals with combination of haemoglobin AA, high potassium (HK) with brown/white coat colour (AAHKBW) were significantly ($p < 0.05$) superior in most of the milk yield characteristics, while those with combination of HbAA, high potassium (HK) and white coat colours (AAHKW) were significantly ($p < 0.05$) superior to other combinations in body weight. The results of this study suggest that combination of haemoglobin type, potassium type and coat colour could be used as indirect selection criteria for milk yield and body weight in goats.

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Keywords: Haemoglobin type; potassium types' coat colour; milk yield; agropastoral goats.

1. INTRODUCTION

Improvement of goats that are indigenous to Nigeria for economically important traits depends on selection of future breeding stock whose performance is better than the average population. This increase can only be made when genetic variations can be detected in the animal population [1,2]. To detect the variance between the selected stock and the general population, performance record must be obtained after a given generation interval. However, this time can be shortened through indirect selection criteria such as blood biochemical polymorphism; which can be determined quickly and in the early stage of life. The introduction of electrophoresis for the detection of polymorphism at protein loci has been employed for measurement of variation in livestock [1]. Information obtained from electrophoresis study could be used as genetic markers for important economic traits and could aid considerably in the selection of superior animals for breeding purposes [1,2].

Haemoglobin which is erythrocyte protein has been reported to be a useful marker through which many economic traits, with which it is associated, have been improved in farm animals [3]. Three types of haemoglobin variants have been identified in goats; they include AA, AB and BB [3,4]. Potassium, on the other hand, is one of the intracellular elements which constitute the structure of an organism; its main function is to regulate the intracellular density of cells [5]. In ruminant, there are two potassium types, high Potassium (HK) and low potassium (LK); and potassium types have been proved to be genetically controlled [6].

Many studies have been conducted to determine polymorphic genes and to evaluate the relationship between these genes and production traits in cattle [7], goat [8], and sheep [3,9,10]. These relationships have been utilized as polymorphic marker among these domestic animals. The coat colour of an animal is important trait that allows easy differentiation among individuals and breeds by farmers. Coat colours allow one to differentiate among individuals within the same breed regarding intensity, patterns and amount of each colour [11]. Coat colour has been shown to be related to productivity in livestock [12,13].

Haemoglobin and potassium polymorphism can only be determined through laboratory test whereas coat colour which has been reported to be associated with productivity in animals can be identified visually without any cost. This study discovers the combined effects of haemoglobin type, potassium type and coat colour variation on milk yield characteristics in goats. And can be beneficial for early detection of functional stock for breeding purposes as these three parameters are determined at an early stage of life. Thus, eliminating the long process of raising inferior animals to maturity before selection. This study will make it possible for rural farmers to quickly select the coat colour best for required production without any cost. In Nigeria, there is paucity of information on combined effects of haemoglobin type, potassium type and coat colour on milk yield characteristics in indigenous breeds of goats. Therefore, the objective of this study was to evaluate the combined effects of blood polymorphism and coat colour on milk production traits in goats.

2. MATERIALS AND METHODS

2.1 Study Area

The Study was carried out in Jigawa and Katsina States, both within the Sudan savannah zone of North-West Nigeria. Katsina lies between latitude 13º01' north of the equator and longitude 07º41' East of Greenwich meridian. It is situated at an altitude of 464 m (1525 ft) above sea level. 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 19º-38º in the cold, dry season [14]. Jigawa State falls within latitude 11º-13ºN and Longitude 8º-10ºE; the State has an altitude of between 400 – 600 m above sea level. The mean annual rainfall varies from 500 mm to 1000 mm. The mean daily maximum and minimum temperatures are 35°c and 19°c respectively [15].

2.2 Animals and their Management

Smallholder agropastoral goat herds were studied between May 2010 and June 2011.The goats were under semi-intensive system of management. The animals were taken out to graze every morning from 8.00am to 5.00pm by children and were penned at night. The goats were given water and supplement which included groundnut haulms, cowpea haulms and dry grasses, before setting out for grazing every morning. Newborn kids were left to suckle their dams freely for the first 6 days postpartum to enable the kids to take advantage of colostrums. Each animal was tagged with a number of individual identification.

2.3 Data Collection

A total of 250 does (whose parties were between 1-6 and average body weight of 28.84 ±0.41 kg) were hand-milked twice a week and the milk obtained per each milking per doe was measured using graduated plastic beakers. Milking of does commence from 7th day postpartum and lasted 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 defined as partial morning milking (PMM). Kids were separated from their dams at 6.00 pm on the evening preceding 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 am 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. Coat colour was identified by visual appraisal and recorded accordingly.

2.4 Milk Yield Characteristics

Milk yield characteristics were measured as follows:

Average Daily Yield (ADY): - As average of all test day yields within the milking period.
Initial Yield (IY): - As milk yield at day 7 postpartum
Total Yield (TY): - As milk production during the lactation period up to the point where the production of the doe dropped below 100ml.
Peak Yield (PY): - As the highest test day yield during the lactation period
Peak day (PD): - As the day corresponding to the highest yield within the lactation period
Lactation Length (LL): - As the period from kidding to the point when the milk yield of the doe falls below 100ml

2.5 Blood Collection and Preparation for Analysis

Five (5) ml of blood samples were collected from 250 does and was used to analyze for haemoglobin and potassium types at haematological laboratory of Bayero University Kano Teaching Hospital Kano, Nigeria. The blood samples were collected by jugular venipuncture, using needle and syringe into a test tube containing ethylene diamante tetra acetic acid (EDTA) as anticoagulant and examples were properly labeled. The blood samples were then washed with normal saline and haemolysis 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 250v 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 [16] and [17]. Potassium concentrations in the blood were determined by colorimetric method using the spectrophotometer. The erythrocyte potassium (Ke) below or equals to 13.00mmol/L was labeled Low Potassium (LK). Conversely, the erythrocyte potassium above 13mmol/L was tacked High Potassium (HK) [18].

2.6 Statistical Analysis

The combined effect of haemoglobin type, potassium type and coat colour (Hb - K - CC) on milk yield characteristics was obtained using one way analysis of variance (ANOVA) with General Linear Model of SAS [19], the model used was

$$Y_{ijk} = \mu + HK_{ij} + HC_{ik} + KC_{ik} + HKC_{ijk} + E_{ijk}$$

Where

Y_{ijln} = Measurement on traits
μ = Population mean
$(HK)_{ij}$ = Combined effect of i^{th} haemoglobin and j^{th} potassium (i = AA, AB, BB; j= Lk, Hk)
$(HC)_{ik}$ = Combined effect of i^{th} haemoglobin and k^{th} coat colour (i = AA, AB, BB; k= Dark Brown, brown/white, white, light brown, brown/black
$(HKC)_{ink}$= Combined effect of i^{th} haemoglobin, j^{th} potassium and k^{th} coat colour

E_{ijk} = Random error effect the significant differences among means were assigned using Duncan Multiple Range Test method.

3. RESULTS

The variation in mean values of milk yield traits with combined haemoglobin - potassium types (Hb-K type) is shown in Table 1. The results showed that goats with homozygote Hb allele AA and high potassium (HK) were significantly (p < 0.05) heavier (body weight) than the other Hb-K types. Whereas those with homozygote Hb allele AA and low potassium (LK) were significantly (p < 0.05) lighter in weight, but had significantly (p<0.05) lower milk yield than their counterpart with other Hb-K combinations. However, does whose Hb-K type were HbAB and HK, respectively had the highest milk yield.

The combined effect of haemoglobin types and coat colour (Hb-CC) on body weight and milk yield traits is shown in Table 2. Goats with white coats having homozygote Hb type AA (AAW) had significantly (p < 0.05) higher body weight, while those with heterozygote Hb type AB (ABW) had the lowest BWT. However, combined effect of Hb-CC on milk yield characteristics indicate that tall goats with brown-white (BW) coat colour irrespective of their Hb types had significantly (p<0.05) higher PY and longer LL, while those with dark brown (DB) coat colour had significantly (p<0.05) higher ADY and PY. Goats with white coat colour irrespective of their Hb type had lower milk yield characteristics.

The variation in mean values of body weight and milk yield traits with combined potassium and coat colour type (K-CC type) is shown in Table 3. The results showed that goats with white coat colour and high potassium (HKW) had significantly (p < 0.05) higher body weight than the other K-CC type, while the dark brown coat colour (DB) goats irrespective of their K-type had the lowest BWT. The combined effect of K-CC type on milk yield characteristics indicates that does with high potassium and black brown coat colour (HKBB) had significantly (p< 0.05) longer Lactation length. Whereas those with HK and white coat colour (HKW) had significantly (p < 0.05) short LL. The dark brown coat colour goats, irrespective of their K type (HKDB and LKDB) had significantly (p < 0.05) higher PY than the other K-CC types.

The combined effect of haemoglobin, potassium and coat colour type (Hb-K-CC type) on milk yield characteristics was not significantly different (P>0.05) except on IY and LL. The brown/ white (BW) coat colour goats with homozygote Hb type AA and heterozygote AB with high potassium HK (AAHKBW and ABHKBW) had higher IY and longer LL than the other HB-K-CC types. Whereas those with dark brown (DB) coat colour and high K, irrespective of Hb type (AAHKDB, ABHKDB and BBHKDB) had significantly (p< 0.05) lower IY and shorter LL (Table 4).

4. DISCUSSION

Animals of HK phenotypes performed better than LK phenotypes in milk yield and body weight in the present study. This observation is contrary to reports of [20] who observed that Awassi sheep with LK were superior to those with HK in milk yield traits. This is probably due to geographical location, HK has been reported to favour animals in high altitude (which the study area is located) in production traits [9]. Animals with HK phenotypes possessing either heterozygous haemoglobin HbAB or homozygous HbBB were identified as best for body size and milk production (meat and dairy) combined. This observation was contrary to reports of [6] who reported that sheep with LK type had heavier weight at birth and weaning compared to those with HK. Animals with homozygous haemoglobin

Table 1. Body Weight and milk yield traits of goats in relation to haemoglobin and potassium types combinations (mean ± se)

CMT	BW (kg)	ADY (g)	TY(kg)	IY(g)	PY(g)	LL(days)
AAHK	$29.142±0.23^a$	$253.91±0.31^b$	30.30±0.22	240.92±0.55	$360.77±6.32^b$	$119.34±1.72^a$
AALK	$28.53±0.33^{ab}$	$254.34±1.58^b$	28.06±1.14	245.11±2.74	$354.50±3.18^b$	$110.33±3.77^b$
ABHK	$27.72±0.06^{ab}$	$284.79±9.49^a$	33.69±0.79	253.95±1.89	$430.00±19.06^a$	$118.27±1.67^a$
ABLK	$26.55±0.35^b$	$234.86±1.67^b$	29.16±1.21	241.29±2.89	$337.35±3.36^b$	$123.92±3.96^a$
BBHK	$27.53±0.07^{ab}$	$256.03±1.09^b$	31.24±0.21	244.99±0.51	$388.27±2.20^{ab}$	$122.00±3.20^a$

AAHK=Combination of HbAA and HK, AALK=Combination of HbAA and LK, ABHK= Combination of HbAB and HK, ABLK= Combination of HbAB and LK, BBHK= Combination of HbBB and HK, CMT = combinations, obs = observation, BW= Body weight, HG = Heart girth, BL = Body length, ADY = Average daily yield, TY= Total yield, IY= Initial yield, PY= Peak yield, LL=lactation length, a, b, = column means under the same factor with different superscripts differ significantly (p < 0.05).

Table 2. Body weight and milk yield traits of goats in relation to haemomoglobin types and coat colours combinations (mean±s.e)

Combination	BW(kg)	ADY (g)	TY (kg)	IY(g)	PY (g)	LL(days)
AABB	33.33±1.96^{ab}	249.50±9.52^{ab}	23.41±9.52	271.00±15.20^{ab}	370.00±19.08^{a}	94.00 ± 3.67^{b}
AADB	26.49±0.09^{b}	254.72±0.41^{a}	28.91±0.30	226.37±0.67^{b}	366.12±0.84^{a}	113.51±1.72^{ab}
AAW	36.33±1.96^{a}	227.74±9.52^{b}	26.82±6.80	243.33±15.20^{ab}	323.33±19.00^{b}	117.43 ±8.21^{ab}
AABW	29.28±0.18^{ab}	254.52±0.89^{a}	32.48±0.63	269.34±1.42^{ab}	350.28±0.22^{a}	126.00 ±2.51^{a}
ABDB	26.71±0.08^{ab}	258.77±1.24^{a}	33.51±4.08	233.25±0.64^{ab}	395.87±2.48^{a}	129.50 ±1.65^{a}
ABBW	29.25±0.16^{ab}	241.65±0.79^{ab}	30.87±0.56	319.60±9.12^{a}	343.75±1.59^{a}	127.75 ±2.36^{a}
ABLB	29.75±1.47^{ab}	234.18±7.14^{ab}	25.49±5.10	242.50±11.40^{ab}	341.25±14.31^{a}	108.87 ±7.10^{ab}
BBDB	27.39±0.25^{ab}	241.68±0.40^{ab}	22.71±0.88	235.43±1.98^{ab}	355.24±0.80^{a}	94.00 ± 2.96^{b}
BBBW	34.00±1.18^{ab}	238.54±5.71^{ab}	27.53±0.28	268.19±1.26^{ab}	386.00±11.45^{a}	116.20 ±6.37^{a}

AABB= combination of HbAA and brown/black colour, AADB= combination of HbAA and dark brown colour, AAW= combination of HbAA and White colour, AABW = combination of HbAA and brown/white colour, ABDB = combination of HbAB and dark brown colour, ABBW = combination of HbAB and brown/white colour, ABLB = combination of HbAB and light brown colour,BBDB= combination of HbBB and dark brown colour, BBBW = combination of HbAA and brown/white colour, obs = observation, BW = Body weight, ADY = Average daily yield, TY= Total yield, IY= Initial yield, PY= Peak yield, LL = lactation length, a, b, = column means under the same factor with different superscripts differ significantly ($p < 0.05$)

Table 3. Body weight conformation and milk yield traits of goats in relation to potassium types and coat colours combinations (mean ±s.e)

CMBS	BW (kg)	ADY (g)	TY (kg)	IY(g)	PY(g)	LL(days)
HKBB	31.25±1.48^{ab}	237.51±7.30	32.720±5.07	263.25±20.00^{a}	355.00±14.57^{ab}	135.50±7.13^{a}
HKDB	26.84±0.04^{b}	259.58±0.20	33.39±0.34	231.11±0.28^{ab}	364.69±0.41^{a}	129.92±1.20^{ab}
HKW	34.67±1.97^{a}	240.37±9.78	25.71±6.76	250.00±13.33^{ab}	320.00±19.43^{ab}	105.66±8.24^{b}
HKBW	29.42±0.10^{ab}	247.54±0.49	28.66±0.14	273.76±0.67^{a}	354.15±0.98^{ab}	116.33±1.85^{ab}
HKLB	29.40±1.18^{ab}	233.08±5.87	29.94±4.05	250.00±8.00^{ab}	343.00±11.66^{ab}	127.40±6.39^{ab}
LKDB	25.83±0.24^{b}	250.93±1.22	28.04±0.84	231.42±1.66^{ab}	368.00±2.42^{a}	112.58±2.91^{ab}
LKW	27.67±1.97^{ab}	219.24±9.70	27.45±6.76	196.67±13.33^{b}	285.00±19.43^{b}	124.00±8.24^{ab}
LKBW	30.41±0.49^{ab}	246.71±2.40	29.725±1.69	265.83±3.33^{a}	329.08±4.85^{ab}	119.92±4.12^{ab}

HKBB = combination of HK and brown/black colour, HKDB = combination of HK and dark brown colour, HKW = combination of HK and white colour, HKBW = combination of HK and brown/white colour, HKLB = combination of HK and light brown colour, LKDB = combination of LK and dark brown colour, LKW = combination of LK and white colour, LKBW = combination of LK and brown/white colour , obs = observation, BW= Body weight, ADY = Average daily yield, TY= Total yield, IY= Initial yield, PY= Peak yield, LL=lactation length; a, b, = column means under the same factor with different superscripts differ significantly ($p < 0.05$)

.Table 4. Milk yield traits of goats according to combined haemoglobin type, potassium type and coat colour (mean±s.e)

CMB	BW(kg)	ADY(g)	TY (kg)	IY (g)	PY (g)	LL(g)
AAHKW	38.50±4.25^{a}	240.00±20.32	22.56±15.62	230.00±31.54^{b}	305.00±40.50	94.00±9.86^{c}
AAHKDB	27.01±0.78^{b}	254.81±3.72	29.28±3.72	228.35±5.94^{b}	364.07±7.46	114.93±1.80^{b}
AAHKBW	28.72±1.20^{b}	253.36±5.77	33.94±4.43	319.60±20.65^{a}	386.00±25.79	134.00±2.80^{a}
ABHKW	27.00±6.03^{b}	240.00±28.85	26.97±22.19	230.00±46.06^{b}	350.00±57.52	110.00±14.02^{b}
ABHKDB	27.09±0.77^{b}	240.99±3.69	27.32±2.84	231.10±5.89^{b}	350.93±7.36	113.37±1.79^{b}
ABHKBW	30.2±1.20^{ab}	245.37±5.77	31.83±4.43	277.00±9.21^{ab}	356.00±11.50	129.72±2.80^{ab}
BBHKDB	27.94±1.34^{b}	261.76±6.45	28.75±4.95	236.25±10.30^{b}	390.75±12.86	109.65±3.13^{b}
BBHKBW	34.0±2.70^{ab}	238.54±12.94	31.29±9.95	268.36±9.21^{ab}	356.20±11.50	131.20±6.28^{ab}

AAHKW = COMBINATION OF HbAA, HK-type and white coat colours, AAHKDB = COMBINATION OF HbAA, HK-type and dark brown colours, AAHKBW = COMBINATION OF HbAA, HK-type and brown/white coat colours, ABHKW = COMBINATION OF HbAB, HK-type and white coat colours, ABHKDB = COMBINATION OF HbAA, HK-type and dark brown coat colours, ABHKBW = COMBINATION OF HbAB, HK-type and brown/white coat colours, BBHKDB = COMBINATION OF HbBB, HK-type and white coat colours, BBHKBW = COMBINATION OF Hb-BB, HK-type and brown/ white coat colours, cmbs = combination, BW = Body weight, ADY = Average daily yield, TY= Total yield, IY= Initial yield, PY= Peak yield, LL=lactation length; a, b, = column means under the same factor with different superscripts differ significantly ($p < 0.05$).

HbAA and HK (AA-HK) phenotype favoured body size alone. When coat colour was combined with haemoglobin and potassium type to test their combined effect on milk yield and conformation traits, only few of the combinations reached significance at generally accepted levels of probability. Animals with Hb allele AA (HbAA), high potassium (HK) and white coat colour (AAHKW) were heavier (higher bodyweight) than other Hb-K-CC types. [21] documented that the Sahel goats are largest in size within the Nigerian breeds of goats, and the white coat colour in the present study were the Sahel goats. [22] reported that Hb alleles A are favoured by geographical location of high altitude. [23] also reported that HbAA are also favoured at location with harsh weather condition. Potassium allele HK have been reported to fit most in environment with high temperature [10]. All these description fit the geographical location in which this study was carried out, and could have contributed to AAHKW superior performance in body conformation and being intermediate in milk yield.

The combined effect of Hb-K-CC on milk yield traits indicated that brown /white (BW) goats with HK irrespective of their Hb-types performed slightly better than other Hb-k-CC types, but had significantly higher TY and LL. [24] explained that the lactation milk yield (total milk yield) for a particular lactation determines the productivity of the animal. And the total yield is determined by the average daily yield and lactation length of the animal. In the present study animals with AAHKBW had the highest record for total yield though not significant, and their lactation length was longer than ABHKBW and BBHKBW. The brown /white (BW) coat coloured goats are possible crossbreds between Red Sokoto goats and the Sahel goats. [25] indicated that the Red Sokoto goats are most efficient in terms of milk production among the Nigerian breeds. [26] further reported that the Sahel goats were intermediate or moderate in terms of milk production. Therefore, heterosis resulting from this crossbreeding probably could have enhanced the performance of the brown /white (BW) animals in terms of milk yield. [27] explained that crossbred animals tend to give more milk than the purebreds. The inclusion of coat colour in the study was to enable the rural farmers who may not have the resources and facilities to carry out any laboratory test, to know which colour to select in terms of meat or dairy production. The result of this study will aid the breeders and rural farmers to select goats at an early stage using these polymorphic traits and coat colour. However, further scientific studies should be carried out with larger sample size to avoid bias and tendency for results to skew towards one direction.

5. CONCLUSION

The combined effect of haemoglobin type, potassium type and coat colour on milk yield and conformation traits of goats showed that does with HbAA, HK and brown/white coat colour (AAHKBW) recorded the highest values regarding milk yield characteristics. While does with HbAA, HK and white coat colour (AAHKW) recorded the highest benefits in terms of body weight. Selection of animals for milk and body weight based on the combination of polymorphic genes and coat colour (Hb-K-CC) would reduce the time and resources spent on keeping inferior animals in the stock to obtain performance records. This is because these polymorphic genes and coat colour variations can be identified at an early age in life. Therefore, these polymorphic genes and coat colour can be used as indirect selection criteria for milk yield traits and body weight in goats.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Salako AE, Ijadunola TO, Agbesola YO. Haemoglobin polymorphism in Nigerian Indigenous small ruminant populations preliminary investigation. African Journal Biotechnology. 2007;6(22):2636-2638.
2. Akpa GN, Ibrahim OA, Yakubu H, Kabir M. Sexual dimorphism, haemoglobin polymorphism and body mensuration characteristics of Red Sokoto goats. Proceedings of the 35th Annual Conference of Genetic Society of Nigeria 10th -14th October, 2011, Ahmadu Bello University, Zaria. 2011;2-7.
3. Akinyemi MO, Salako AE. Hemoglobin polymorphism and morphometrical correlates in the West African Dwarf Sheep of Nigeria. International Journal Morphology. 2010;28(1):205-208.
4. Sam IM. Relationship of haemoglobin and potassium polymorphism with

conformation, milk production and blood biochemical profiles in agropastoral goat. Ph.D Thesis. Ahmadu Bello University, Zaria; 2012.

5. Milewski S, Szczepanski W. Effect of Electromagnetic field on meat performance and wool performance of sheep. Arch. Tierz. 2006;49:219-225.
6. Al-Samarrae SH, Younis KH. Blood polymorphism and its relation with sheep production and reproduction. Diyala Agricultural Sciences Journal. 2011;3(1): 10-21.
7. Gonzales P, Tunon MJ, Diaz M, Vallejo M. Blood plasma and erythrocyte sodium concentration of six Spanish cattle breeds. Anales de la Facultad de veterinariade leon. 1984;30:137-145.
8. Soysal MI, Ulku AA. Biochemical polymorphism in some Turkish goat population. In: National Congress on the Animal Production Science. Uludag University, Faculty of Agriculture. 1998;179-189.
9. Shahbabak HM, Shaharbabak MM, Yeganeh HM. Whole blood potassium polymorphism and other blood electrolytes of Varamini sheep in Iran. International Journal of Agriculture and Biology. 2009;9(1):84-86.
10. Gurcan EK, Erbas C, Cobanoglue O. Biochemical polymorphism of erythrocyte potassium and glutathione protein. The relationship with some blood parameters in Kirvircik sheep breed. African Journal of Agricultural Research. 2010;5:1022-1027.
11. Becerril CM, Wilcox CJ, Campus MS, Hansen PJ. Genetic effects and relationship of milk production and percentage of white goats in a subtropical Holstein herd. Brazil Journal Genetics. 1994;17:65-68.
12. Maia ASC, Silva RG, Bertipagha EC, Munoz MC. Genetic variation of the hair coat properties and the milk yield of Holstein cows managed under shade in tropical Environment. Brazilian Journal of Veterinary Science. 2005;42:180-187.
13. Mustafa O, Tozlu H, Onder H. Effect of hair colour variation on milk production and kid growth in Turkish hair goat. Journal of Animal and Veterinary Advances. 2011;10(8):1037-1040.
14. Ati OF, Iguisi EO, Afolayan JO. Are we experiencing drier conditions in the Sudano Sahelian Zone of Nigerian? Journal of Applied Sciences Research. 2007;3(12):1746-1751.
15. Available: www. Saterliteview.com
16. Das DK, Sinha R, Dattagupta R, Senapti PK. Association of haemoglobin types with some menstruation and reproductive characteristics in Garole sheep. Indian Journal of Animal Sciences. 2004;74(4): 382-384.
17. Tella MA, Taiwo VO, Agbede SA, Alonge OD. The influence of haemoglobin types of incidence of babesiosis and anaplasmosis in West African Dwarf and Yankasa sheep. Tropical Veterinary Journal. 2000;18:121-127.
18. Galip N, Elmaci C. Erythrocyte potassium polymorphism and relationship with blood parameter in Turkish Hair Goats. Journal of Genetic Breeds. 2001;55:183-185.
19. SAS. Statistical analysis system, Version 8.0 SAS Institute Inc. Cary North Carolina, USA; 2000.
20. Gunes N, Aydin C, Udum CO, Dikmen S, Ozmen O. Erythrocyte potassium, sodium and glutathione concentrations and their relationship with reproduction, body weight and fleece weight traits in Awassi sheep, Archiv Tierzucht. 2008;51:479-486.
21. Ijomanta, Oforodo Esther. Genetic profile of morphological traits and their association with production capacity of red Sokoto goats in Katsina State of Nigeria. M.Sc. Thesis, Ahmadu Bello University, Zaria; 2012.
22. Ibrahim AO. Haemoglobin polymorphism and body mensuration characteristics of Red Sokoto goats. M. sc. Thesis Ahmadu Bello University, Zaria; 2010.
23. Hrinca GH. Haemoglobin types in the carpathian breed and their relevance for goat Adaptation. Universitation de Stiinte Agricolesi Medicina veterinara Iasi. Lucrari Stiintifice. Seria Zootehnie, 2010;53: 310-314.
24. Akpa GN, Osuhor CU, Lakpini CAM, Owoeye O. Effect of milking frequency on milk yield and composition of Red Sokoto goats. Journal of Science of Agriculture, Food Technology and the Environment. 2005;5:68:73.
25. Akpa GN, Osuhor CU, Olugbemi TS, Nwani PI. Milk flow rate and milking frequency in Red Sokoto goats. Pakistan Journal of Nutrition. 2003;2(3):192-195.

26. Zahraddeen D, Butswat ISR, Mbap ST. A note on factors influencing milk yield of local goats under semi-intensive system in Sudan Savannah ecological Zone of Nigeria. Livestock Research for Rural Development. 2009;21(3)1-6.

27. Awgichew K, Yacob Y, Fletcher I. Productivity of pure-bred Adal and quarter bred Saanen x Adal goats in Ethiopia. Diary Science Abstract. 1991;53(3):4951.

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