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Relationships between body conformation, hematological, and serum biochemical parameters in Kiko and Nubian goat bucks under a semi-intensive management system

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Abstract
The objective of this study was to investigate breed and body conformation influences on the serum biochemical and hematological parameters of Kiko-meat and Nubian-dairy goat bucks. Most body conformation traits were significantly higher ($P<0.01$) in Kiko than in the Nubian bucks. The hemoglobin (HGB) values ranged from (9.1 to 12.4 g/dl and 7.4 to 10.0 g/dl with the Kiko bucks also having the highest value ($P<0.05$). The mean concentration value of glucose for Kiko and Nubian bucks were 69.2 and 68.8 mg/dl, respectively. Body weight (BWT) showed negative correlation with WBC (r = -0.34), however, was highly correlated with RBC (r = 0.73), lowly correlated with platelets counts (PLT) (r = -0.13), negatively correlated with Mononucleosis (MONO) (r = -0.55), and showed positive relationship with mean cell hemoglobin (MCH) (r = 0.41) and eosinophil counts (EOS) (r = 0.50) and Hematocrit (HCT) (r = 0.66) respectively. The hematology and serum biochemistry data in the present study are the first reference values obtained for Kiko and Nubian goats raised under in Alabama under semi-intensive production system, and will provide goat producers the ability manage and monitor health and disease status of Kiko meat and Nubian dairy goat bucks in Alabama.

Keywords: body conformation, hematology, serum biochemistry, Kiko, Nubian goat bucks

Introduction
In southeast United States, efficient meat and/or dairy goat production is difficult because warm, humid pasture conditions are optimum for gastrointestinal parasites. Internal parasites represent the greatest threat to goat productivity, health, and survival (Solaiman, 2007) [51]. Kiko breed of meat goat was developed in New Zealand and introduced to the US. The composite Kiko breed resulted from a series of crosses involving feral does and varying breeds of dairy bucks (Batten *et al*. 1987) [10]. Anglo-Nubian goats were developed in England by crossing British goats with bucks of African and Indian origin (Briggs, *et al*. 1980) [14]. The Anglo Nubian is an all-purpose goat, useful for meat, milk and hide production.
Blood act as a pathological reflector of the status of the exposed animals to toxicants and other conditions. The examination of blood provides the opportunity to clinically investigate the presence of metabolites and other constituents in the body of animals and it plays a vital role in the physiological, nutritional and pathological status of an animal. The hematological and serum biochemical parameters are often a reflection of the effects of dietary treatment on the animals in terms of the type and amount of feed ingested and were available for the animals to meet its physiological and metabolically necessities (Pradhan, 2016) [45], also the level of anti-nutritional element factors present in the feed will also influence the hematological and biochemical values (Awodi *et al.* 2005) [8]. There is a great variation in the hematological and serum biochemical parameters observed between breeds of goats (Pradhan, 2016) [45], and this regard, it may be difficult to formulate a universal metabolic profile test for goat. These differences have further underlined the need to establish appropriate physiological baseline values for various breeds of goats in Alabama, which could help in the realistic evaluation of the management practice, nutrition and diagnosis of their health condition.

Hematological studies are useful in the diagnosis of many diseases as well as investigation of the extent of damage to blood (Onyeyili, *et al*. 1992; Togun *et al.* 2007) [40, 56]. Hematological studies are of ecological and physiological interest in helping to understand the relationship of blood characteristics to the environment (Ovuru and Ekweozor, 2004) [43] and so could be useful in the selection of animals that are genetically resistant to certain diseases and environmental conditions (Mmereole, 2008) [32]. As reported by Isaac *et al.* (2013) animals with good blood composition are likely to show good performance. Laboratory tests on the blood are vital tools that help detect any deviation from normal in the animal or human body (Ogunbajo *et al*, 2009) [37]. The examination of blood gives the opportunity to investigate the presence of several metabolites and other constituents in the body of animals and it plays a vital role in the physiological, nutrition and pathological status of an organism (Aderemi, 2004) [4].

According to Olafedehan *et al.* (2010) [38], examining blood for their constituents can provide important information for the diagnosis and prognosis of diseases in animals. Blood constituents change in relation to the physiological conditions of health (Togun *et al.* 2007) [56]. These changes are of value in assessing response of animals to various physiological situations (Khan and Zafar, 2005) [27]. According to Afolabi *et al* (2010), changes in hematological parameters are often used to determine various status of the body and to determine stresses due to environmental, nutritional and/or pathological factors. There is considerable information about the normal blood hematological and biochemical parameters the domestic animal species, but the values are expected to vary according to the breeds, different environmental factors and the different methods of management Influence (Ekiz, and Yalcintan, 2013) [23].

Variations exists in hematological and serum biochemical parameters in breeds of goat because of genotype, ages, and gender or livestock production systems. These differences have further underlined the need to establish appropriate physiological baseline values for common breeds of meat goats (Boer Kiko, Spanish) and dairy goats (Anglo-Nubian) in Alabama. The objective of this study was to investigate breed and body conformation influences on the serum biochemical and hematological parameters of Kiko-meat and Nubian-dairy goats managed under semi-intensive production system in south east Alabama, and establish reference values that can be used to aid veterinarians and producers in the interpretation of the laboratory data and for the selection of the appropriate treatment for meat and dairy goats in the region.

Materials and Methods

Animal Management

This study was conducted at the Caprine Research and Education Unit of the George Washington Carver Agricultural Experiment Station at Tuskegee University, Tuskegee, Alabama (32.43N, 85.71W). Tuskegee is located in the southeastern region of the United States, sits 183 m above sea level, and has an annual precipitation amount of 1222 mm. The Tuskegee University Animal Care and Use Committee approved herd management protocol used in this project.

For this project, mature and healthy Kiko bucks (n = 15; body weight (BWT) = 45. 4± 2.0 kg; age = 9-12 months, Nubian bucks (n= 15; BWT = 21.9± 2.8 kg; age = 7-9 months) semi intensively managed bucks were utilized. Bucks were strategically dewormed twice during the research period. All animals were managed on tall fescue (*Festuca arundinacea*) and bermudagrass (*Cynodondactylon*) pastures, and supplemented with bermudagrass hay (*Cynodondactylon*) for *ad libitum* consumption. Animals were also supplemented with 341 g/d of alfalfa (17% crude protein, 1.5% crude fat, 30% crude fiber) and corn (7% crude protein, 3% crude fat, 4% crude fiber), and had access to trace mineral salt block.

Body Conformation Measurements

Prior to bleeding, bucks were physically examined. For each animal body weight was recorded using a scale, and body condition scores (BCS) were evaluated subjectively (ranging from 1= emaciated to 5= obese). Shoulder width (SW) was determined with the aid of a tape measure, as the horizontal distance between the processes on the left shoulder and those of the right shoulder blade. Chest girth (CG) was measured with the aid of a measuring tape around the chest, just behind the front legs; body length (BL) was measured from the sternum to the aitch bone and hip width (HW) was measured using a plastic measuring tape, while height at wither (HTW) was measured vertically from thoracic vertebrae to the ground using a metal ruler.

Blood Sampling and Analysis

Blood samples were collected with 18-ga needle by jugular venipuncture. The samples were left to clot and then centrifuged at 3000 rpm for 15 min, and the serum is collected. Serum was kept frozen at −20°C until it was used for the biochemical analysis.

Serum Biochemistry

Serum biochemistry was carried out by using the IDEXX (USA) Catalyst One Automated Chemistry Analyzer which includes the following parameters: Albumin (ALB), alanine aminotransferase (ALT), alkaline phosphatase (ALP), bile acids (BA), cholesterol (CHOL), gamma glutamyl transferase (GGT), total bilirubin (TBIL), and blood urea nitrogen (BUN), aspartate aminotransferase (AST), glucose (GLU), creatinine (CREA), calcium (CA), total protein (TP), and total bilirubin (TBIL)

Hematology

Hematological profiles were also examined in these bucks of Damascus breed. Blood samples were collected with an 18-ga needle by jugular venipuncture. All samples were analyzed within two hours of collection by using IDEXX (USA) Procyte Dx Automated Hematology Analyzer. The EDTA blood samples were analyzed for total white blood cells (WBC), red blood cells (RBCS), hemoglobin (HGD), hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC) and number of platelets (PLT), neutrophils (N), lymphocytes (L), monocyte (M), eosinophil (E), basophil (B) and red blood cells (RBC), hemoglobin (Hb), mean corpuscular volume (MCV),, red cell distribution width (RDW), mean platelet volume (MPV), procalcitonin (PCT) and platelet distribution width (PDW).

Statistical Analysis

All results are expressed as means ± standard deviation (SD). SAS 2012 ® statistical software was used to calculate the minimum and maximum values to determine the range, mean, standard deviation of the mean. The effects of breed on biochemical parameters and hematology profiles of bucks were analyzed by one-way analysis of variance (ANOVA)

using SAS 2012 ® statistical software. If ANOVA showed an acceptable level of significance ($P<0.05$), Duncan Multiple Range Test was applied for post hoc comparison by using the General Linear Model (GLM), procedures of SAS 2012 ®. Pearson's correlation (*Statistix 7*, 2000) Analytical Software, Tallahassee, FL) was used to calculate correlation coefficient (r) and determine the degree of relationship body conformation traits and serum biochemical or hematological variables in Nubian and Kiko bucks.

Results and Discussion

Body Conformation Traits

The mean (± SD) of different linear traits in both Kiko and Nubian bucks is presented in Tables 1 and 2 respectively. Measurements of most of the traits were significantly higher ($P<0.01$, Table 3) in Kiko than in the Nubian bucks (45.4 vs. 27.1 kg, BWT, 3.2 vs. 2.0, BCS, 86.5 vs 71.2 cm, CG, 102.4 vs. 90.1 cm, BL, 59.6 vs. 45.3 cm, SW, 69.9 vs. 61.2 cm, HTW, 61.0 vs. 47. 5, cm and 25.7 vs. 21.9 cm SC respectively. An increase in measurement in various phenotypic traits in the Kiko goat bucks as compared to the Nubian goats could be due to the initial age and body weight differences between the bucks, Kiko (BWT = 45. 4± 2.0 kg; age = 9-12 months and Nubian (BWT = 21.9± 2.8 kg; age = 7-9 months) respectively.

One of the most common and informative measure of animal performance is body weight (Adeyinka and Mohammed, 2006) [5]. It has been found to be very effective in assessing the reproductive efficiency in goats (Bongso *et al*. 1982) [13] and it provides readily obtainable and informative measure of selection, feeding and healthcare (Thiruvenkanden, 2005) [55]. Bhadula *et al*, (1979) reported that the best method of weighing animals without a scale is to regress body weight on certain body characteristics which could be readily measured. According (Mohammed and Amin, 1996; Fourie *et al*, 2005 & Raji *et al*., 2008), body weight in correlation with body conformation is very useful and helpful in the development of any selection criteria.

BCS is a subjective measurement technique utilized to determine the degree of body fat reserve and muscle thickness of farm animals (Singh *et al*. 2015) [49] and is a mode for producers to assess adequate or insufficient poise of nutrition required to sustain a healthy animal for grazing and reproductive efficiency (Treacher *et al*. 1986) [57].

However, body condition alone cannot be assessed by visual inspection but by palpable evaluation. According to Treacher *et al* (1986) [57], three regions, the lumbar region (loin), sternum, and rib cage are evaluated during BCS assessment. The lumbar region measures the amount of fat over the vertebrae, the sternum (breastbone) measures the size of fat on the sternum, and lastly, the rib cage evaluates the fat covering of the ribs. Additionally, there are two methods used to assess the degree of muscle thickness on goats. The first method is evaluating the fat depots over the ribs, shoulder and back, whereas, the second assessment is to measure the fat depots covering over the short rib and tail head.

Breed Differences in Hematology

The results of the hematological values for adult goat in both Kiko and Nubian bucks is shown in Tables 4, 5 and 6 respectively. The hematocrit (HCT) was significantly different ($P<0.05$) between breeds with Kiko goats buck having the highest (41.6%). The hemoglobin (HGB) values ranged from (9.1 to 12.4 g/dl and 7.4 to 10.0 g/dl with the Kiko bucks also having the highest value (12.4g/dl). The highest value of 24.3 M/µl was observed in Kiko goat bucks for red blood cell count (RBC) while Nubian goats buck had the least (19.4 M/µl) MCH values ranged from 4.2 to 5.8 pg in Kiko bucks to 3.9 and 5.4 pg in Nubian bucks. Nubian goats were observed to have the highest mean corpuscular hemoglobin concentration (MCHC) (30.9 vs. 27.1 g/dL) and white blood cell count (WBC) (12.3 vs. 10.9 K/ µL) respectively. The lymphocytes values ranged from 49.5.00% in Nubian bucks to 37.0% in Kiko bucks. Kiko bucks had the highest neutrophils (69.00%) followed by Nubians that had (64.00%). Eosinophils was observed to be highest (4.9%) for Kiko buck followed by Nubians (1.08%). Monocytes values ranged from 3.2 to 7.9% in Kiko bucks and 2.1 to 13.0% in Nubians (Tables 4 and 5).

HGB (Hemoglobin) values in this study was higher than values obtained for Bolangir goats (Adegun *et al* .2011) [3]. Earlier reports in Baladi goats Aletor and Egberongbe (1992) [6] and Bolangir goats (Adegun *et al.* 2011) [3] showed lower HGB values. The findings of this study support that HGB varies among breeds of goats. Increase in HGB values in this study may be attributing to increase in environmental temperature. High HGB values indicates either an increase in the number of circulating RBC or reduction in circulating plasma volume (Baneejee, 2007) [9]. Hematological traits especially PCV and HGB often correlated with nutritional status of the animal. However, the primary functions of the erythrocyte are to serve as a carrier of hemoglobin. The higher HGB values observe in this study might likely be a sign of healthier goats. Males have higher PCV and HGB values than females and is a likely hood of inherent sex differences among male and female (Bianca, 1955). Hemoglobin (HGB) concentration in this study fell within the range of high values obtained for Bolangir goats (Adegun *et al* 2011) [3]. The significant breed (Kiko vs. Nubian) of HGB observed in this study may be an indication of better adaptability of the Kiko breed to the humid conditions in south eastern Alabama.

The results of the RBC shows that Kiko bucks had higher RBC values than Nubians. The difference due to breed is a signal of the health status and better adaptability of the Kiko breed in sub-tropical climates Alabama, which is in agreement with the findings of Alex and Verne, (1993) and Addas *et al* (2010) [2]. The values of mean corpuscular volume (MCV) significantly increased while MCHC indicate macrocytic and hypochromic anemia (Campbell *et al.* 2003), probably due to the increased activity of bone marrow and deficiency of some hemopoietic factors. MCHC is very significant in the diagnosis of anemia and also serve as a useful index of the capacity of bone marrow to produce red blood cells. Increased MCV has also been observed in regenerative anemia due to hemolysis and hemorrhages.

A higher MCV values indicates macrocytosis (Coles, 1980) [20]. The total White Blood Cell (WBC) count was higher in this study than values obtained for other breeds of goats and cattle (Anosa, 1988) [7]. Total WBC counts differentials in these adult goats compared well with values obtained for young goats in a study by Pradhan (2016) [45] for three breeds of goats. The higher values obtained in this study suggest well develop immune system of all Kiko and Nubian breeds of goats. In goats like other ruminants, there are more lymphocytes than Neutrophils in circulation (Daramola *et al.* 2005) [22]. The higher values of the WBC observed may also be attributed to the extensively managed goats which makes them face challenges from microbes when on free range. However, the values obtained in this study fell within the

broad range recorded for various breeds of goats (Abdelatif *et al.* 2010) [1]. The white blood cell differentials (lymphocytes and neutrophils) levels are comparable to values obtained for several ruminant animals. In goats like other ruminants, there are more lymphocytes than neutrophils in circulation (Daramola *et al.* 2005) [22]. Lymphocytes are the key elements in the production of immunity. Low levels are observed in some cases of bacterial infections, aplastic anemia, and in some forms of leukemia while high values can be observed in viral infections, and in some forms of leukemia (Dacie, 1991) [21]. Pradhan (2016) [45] obtained the values of (64.8 to 70%) for adult goats and 67.8 to 55.4% for goat kids, while Duke *et al* (1995) reported values ranging from 43.89 to 45.86% for kid goats respectively.

Addass *et al.* (2012) [2] reported that management system had significant effect on PCV indicating a higher effect on semi-intensively kept chicken recording higher values. According to Addass *et al.* (2012) [2] intensively kept chickens recorded higher values for most hematological parameters than semi-intensively kept chickens. Olayemi, *et al* (2000) [39] conducted a study to determine the hematology of the West African Dwarf (WAD) sheep under intensive and extensive management systems in Nigeria. The intensively reared animals showed higher PCV, HGB concentration and MCV than those under extensive management. Both groups of animals had similar MCH, MCHC, Red Blood Cell, (RBC) Total White Blood Cell, lymphocyte, neutrophil, eosinophil and monocyte counts. In another study conducted by Olayemi *et al.* (2000) [39] on the influence of management on the hematology of the white Fulani cattle. The intensively reared animals showed higher Packed Cell Volume (PCV), Red and White cell counts but lower Mean Corpuscular Hemoglobin than those under extensive management.

Furthermore, Coles (1986) [20] and Schalm *et al.* (1975) [48] reported that regardless of age, sex and climate, sheep and goats reared under traditional husbandry system have low hematological values compared to those reared under modern husbandry. Chineke *et al*. (2006) [19] reported that apart from genotype, age, sex, differences in hematological indices may be caused by nutritional, environmental and hormonal factors. According to Ogunbajo, *et al.* (2009) [37] low nutritional grassland, pasture, stress, parturition, climatic factors among others greatly alter the blood values of goats and sheep, as well as other farm animals.

Hematological parameters and its knowledge can be used to assess the health as well as the physiological status of farm animals under consideration. Changes of these parameters have been studied in cattle, sheep and Red Sokoto goats (NAPRI, 1984) [33] There is great variation in the hematological parameters as observed between breeds, ages, sexes, management systems among others in farm animals. These differences have further underlined the need to establish appropriate physiological baseline values for livestock in in Alabama, which could help in realistic evaluation of the management practice, nutrition, diagnosis of health as well as in determining the physiological status of farm animals. Moreover, it is important to establish a baseline index for hematological parameters based on the factors studied and carry out further studies to determine the effects of these factors on these indices.

Breed Differences in Serum Biochemistry

The results of some blood chemistry parameters (means ±SD) of the Kiko and Nubian bucks in this study is shown in Tables 7, 8 and 9 respectively. These include the fallowing parameters: Glucose (GLU), Creatinine (CREA), Blood Urea Nitrogen (BUN), Calcium (CA), Total Protein (TP), Alkaline Aminotrnasferase (ALT), Aspartate Aminotransferase (AST), Alkaline Phosphatase (ALKP) and Total Bilirubin (TBIL). Total protein levels in Kiko and Nubian bucks in this study fall within the ranges published for other goat breeds (Pradhan, 2016; Daramola *et al* 2005) [45, 22], although as with albumin levels breed variations were noted in the Indian goats which cannot be assessed in this study (Ekiz and Yalcintan, 2013) [23]. Ogunbajo *et al* (2009) [37] reported that total protein value in goat serum could be increased until 7.5 g/dl in extensively raised animals. Tambuwal *et al.* (2002) [54] also reported a normal value of 7.0 g/dl; however, they also found significant differences between sexes. Blood proteins play an important role in maintaining overall oncotic potential preventing significant extravasation of fluid from the circulation and so again, it is not surprising that there is no significant variation between the two breeds (7.56 vs.7.60 g/dL; $P>0.05$, Table 9) for total proteins or the overall levels of the globulins or albumin. This s study showed lower ALKP values than that reported in Sokoto red, Sahel and Saanen goats (Tambuwal *et al* 2002) [54]. However, the values of AKLP were slightly higher than that reported in WAD goats (Opara *et al.* 2010) [41]. ALKP constitutes a large group of isoenzymes, which plays important roles in the transportation of sugar, phosphate and it originates from different tissues such as liver, bone, placenta, and intestine (Adedeji, 1992).

Alkaline phosphatase (ALKP) is a leakage enzyme found in bone, the intestines and the liver predominantly (Oduye *et al* 1976) [36]. Elevations can therefore occur due to bone, intestinal or liver disease, or due to bone growth in young animals. Values for the Kiko and Nubian bucks in this study were similar to those reported for other goats (Opara *et al.* 2010) [41]. Electrolyte (calcium) values are also similar to that reported for goats and other ruminants. In all mammals, physiologically normal values for calcium potassium do not exceed 7.5mmol/L as cardiac dysfunction occurs, or become less than 2.5mmol/L due to muscular dysfunction (Elitok, 2012). Diet may also account for the significantly increased total calcium levels in the Nubian versus the Kiko bucks (9.3 vs. 8.4 mg/DL). Calcium: phosphorus ratios often follow an inversely proportionate relationship and again this may account for the results seen here.

Calcium and phosphate levels reported here are within the range for other breeds of goats (Opara *et al.* 2010) [41]. Elevated phosphorus levels may also be seen in cases of advanced renal failure. Lowered calcium levels may be seen in diets deficient in calcium, high in phosphorus or containing compounds such as oxalates (e.g., beet leaves) or phytates (e.g., grains) which bind ionized calcium in the gut and prevent its absorption. This study showed a wide variation in the concentrations of both Aspartate Amino Transferase and the Alanine Amino Transferase (AST and ALT). The comparative value of alkaline phosphate (ALP) in both Kiko and Nubian bucks is in contrast to the findings of Tambuwal *et al* (2002) [54] for Red Sokoto goats. Although ALP level can be influenced by pregnancy, blood pH and disease (Kelly, 1974), the animals in this study were apparently healthy, non-pregnant, and these parameters could not have been influenced by these factors. Age was also observed to have a significant effect on ALP in this study similar to Red Sokoto goats (Tambuwal *et al*, 2002) [54].

Creatinine and urea are often used as an indicator of renal function in mammals with elevations in both parameters being seen in the latter stages of renal failure (Bush, 1991) [16]. It is

interesting to note that there is a statistically significant difference between the two breeds studied (0.80 mg/DL vs. 0.48 mg/DL; $P<0.01$, Table 9) here with the Kiko bucks being greater than the Nubian bucks for both parameters. This is an important feature to note when attempting to interpret results in any renal health assessment. Values from are similar to published values for nutria for creatinine but lower than nutria for urea (Ekiz and Yalcintan, 2013) [23]. However, White Aardi showed significantly higher ($p\leq0.01$) value (1.57 mg/dl) compared to Black Aardi. Belewu and Ogunsola (2010) [11] reported different low creatinine concentrations because of the diet fed to goats, 0.7 mg/dl for un-treated kernel cake (*Jatropha curcas*) and 1.2 mg/dl for goats fed with fungi-treated Kernel cake. The level of creatinine in the blood serum could be altered due to differences in energy and protein content of feeds. Solaiman *et al.* (2009) [50] showed that creatinine levels in male kids increased linearly when cottonseed (*Gosspium hirsutum*) ration was offered to them.

Moreover, a study on goat grazed on rangeland showed that the level of creatinine had varied values depended on certain roughages available in wet and dry periods of grazing (Mellado *et al.* 2006) [29]. The level of creatinine could also be elevated in the serum of goats after water deprivation (Abdelatif *et al.* 2010) [1]. The amount of creatinine secreted daily is a function of the muscle mass and is not affected by diet, age, sex or exercise. It amounts to approximately 2% of the body stores of creatinine phosphate and is roughly 1-2g/day for adult. Female excrete less creatinine than males because of their smaller muscle mass Ganong (2005) [24].

The levels of BUN for the examined bucks were within the normal range (Tables 7 and 8) for goats (10.6 vs. 13.6 mg/dl). Studies reported varied values of BUN in different goat breeds. Benjamin (1989) [12] suggested an average BUN concentration of 21.4 mg/dl, while Bush (1991) [16] found that BUN concentration ranged between 34.6 and 57.4 mg/dl in goats. Many reports suggested that BUN concentration was lower in kids than in adults with no significant differences between the sexes (Castro *et al.* 1977) [17]. Solaiman *et al* (2009) [50] reported a breed by diet interactions effect on BUN values in a study where three goat breeds, that is, Boer, Nubian, and meat Spanish goat were offered lespedeza (*Lespedeza cuneate*) or alfalfa hay (*Medicago sativa* L). In general, lower concentration of BUN is an indication of low dietary protein level or hepatic chronic disease. On the other hand, the increase of BUN could be the result of renal failure and body dehydration (Mishra *et al.* 2013) [31]. Also, Others (Mishra, *et al.* 2013) [31] suggest that lower concentration of BUN is an indication of the dietary protein level or liver chronic diseases.

Hematological and biochemical variables versus body conformation traits

For both Kiko and Nubian bucks, the relationships between various hematological parameters and body conformation traits are presented in Table 10. Body weight (BWT) at bleeding and WBC showed negative correlation (r = -0.34), however, was highly correlated with RBC (r = 0.73), lowly correlated with PLT (r = -0.13), negatively correlated with MONO (r = -0.55), and showed positive relationship with MCH (r = 0.41) and EOS (r = 0.50) and HCT (r = 0.66) respectively. Body condition scores (BCS) showed significant low negative relationship with WBC (r = -0.26), PLT (r= -0.11), MONO (r = -0.43) and MCHC (r = -0.23). However, BCS showed significant ($P<0.05$) positive correlations with HCT (r=0.52), HGB (r = 0.65) and MPV (r = 0.64). Body length (BL) showed significant ($P<0.05$) negative correlations with most hematological variables except HGB (r = 0.58) and EOS (r = 0.73)

The relationships between various biochemical variables and body conformation traits in Kiko and Nubian bucks is presented in Table 11. Body weight (BWT) and ALKP (R = -0.50), ALT (r = -0.53), AST (r = - 0.61) and BUN (r = -0.31) showed negative correlation. However, CREA was highly correlated with TP (r = -020), lowly correlated with GLU (r = -0.23), negatively correlated with TBIL (r = -012). Body condition scores (BCS) showed significant low negative relationship with most serum biochemical variables except CREA (r = 0.79). In addition, Body length (BL) showed significant ($P<0.05$) negative correlations with most all measured biochemical parameters except CREA (r = 0.59)

The body conformation traits and blood variables data of bucks are presented in Tables 2, 3, 4 and 5 respectively. The mean and STD of body weights of Kiko and Nubian bucks were (45.4 ± 4.0 and 27.1 ± 2.8 kg) respectively. Highly Significant ($P<0.01$) breed differences were obtained for body weights. The mean and STD of body condition scores of Kiko and Nubian bucks were (3.2 ± 0.56 and 2.0 ±0.0) respectively. Highly Significant ($P<0.01$) breed differences were obtained for body condition scores for Boer, Kiko and Boer and Kiko crosses. Okere *et al* (2017), have also reported similar findings.

The mean and STD of blood glucose (mg/ dl) in the Kiko and Nubian buck were 69.2 ± 15.4. 68.8 ±7.8, respectively. Non-significant ($P>0.05$) breed differences were obtained for blood glucose levels. Serum total protein (g/dL) values were 7.6 ± 0.5 and 7.5 ± 0.7 respectively. The mean and STD of serum calcium levels (mg/dL) were 8.4±0.7 and 9.35 ±0.32 respectively. The mean values of WBC, RBC, HGB, MONO, MCHC MPV, and MCV within the normal physiological range, whereas the levels of serum calcium and CREA were lower than the normal physiological range (Swenson, 1970) [53].

Body weights are commonly used because measurement is easier and quicker to perform and does not require much expertise. Body weights are commonly used for monitoring nutritional status and growth of animals (Chimonyo *et al.* 2000) [18]. However, the body weight of an animal per se does not reflect its nutritional status (Chimonyo *et al.* 2000) [18].

Body condition scoring describes the systematic process of assessing the degree of fatness of an animal (Nicholson and Sayers, 1987) [34]. The score reflects the plane of nutrition on which an animal has been exposed over a reasonable length of time (Stuth *et al*., 1998) [52]. The loin, ribs, tail head, brisket, flank, vulva and/or rectum and udder are the important parts of the body used in determining the score. Physiologically, the proportions of protein and water of the animal's bodyweight decrease as it gains body condition (NRC, 1996) [35]. Several authors have documented association between body condition scoring and fertility (Buckley *et al*., 2003) [15] and health (Roche and Berry, 2006) [47]. The blood metabolites values in ruminant animals are used to assess the nutritional status, to predict occurrence of metabolic diseases and to diagnose the diseases, and to assess the fertility status of animals (Ingraham and Kappus, 1988) [26]. Although the success of the metabolic profile test is limited because several non-dietary factors like herd origin, stage of lactation, milk yield and season of the year affect the concentration of blood metabolites (Lee *et al*. 1978) [28].

Blood metabolite concentrations represent an integrated index of the adequacy of nutrient supply in relation to nutrient

utilization of goats. They give an immediate indication of an animal's nutritional status at that point in time (Pambu-Gollah *et al*, 2000) [4]. In the dairy industry, the use of metabolic profile les for assessing the nutritional and health status of cows is widespread (Grunwaldt *et al*. 2005) [25]. Use of such metabolites in the management of pasture-raised goats is still uncommon.

Blood glucose has a moderate diagnostic value in the assessment of nutritional status of buffaloes as it varies moderately in blood. Insufficient nutrient intake can reduce circulatory glucose and cholesterol levels. In conditions of undernutrition, the blood levels of propionate and other precursors derived from the diet decrease thus causing a reduction in the rate of glucose synthesis (Reynolds *et al.* 2003) [46].

Total protein levels are lower in young animals and higher in mature animals whilst albumin levels are lower at birth and then increase (Otto *et al*, 2000) [42]. Malnutrition decreases albumin levels. Total protein and albumin reflect availability of protein, and their concentration decline in the face of protein deficiency. On the basis of above observations, it can be concluded that both Kiko and Nubian bucks under a semi-intensive system deficient in the minerals calcium and phosphate whereas their energy requirements are being met with their diet. It is also concluded that blood biochemical profile must be combined with body conformation traits a traditional method for assessment of nutritional status for goats in a pasture management production system.

Table 1: Descriptive Statistics for Body Conformation Traits in Kiko Goat Bucks

Trait	No	Mean	Standard Deviation	Minimum	Maximum
Body Weight, kg (BWT)	15	45.42	4.09	37.19	49.89
Body Condition Scores (1 – 5) (BCS)	15	3.2	0.56	2	4
Chest Girth, cm (CG)	15	86.52	1.85	82.55	88.90
Body Length (BL), cm	15	102.45	7.8	91.44	116.84
Shoulder Width, cm	15	59.65	2.81	55.42	63.500
Height at Withers (HTW), cm	15	69.94	2.73	66.04	76.20
Hip Width, cm	15	61.07	5.22	48.26	66.96
Scrotal Circumference (SC), cm	15	25.733	2.73	20	30

Table 2: Descriptive Statistics for Body Conformation Traits in Nubian Goat Bucks

Trait	No	Mean	Standard Deviation	Minimum	Maximum
Body Weight, kg (BWT)	15	27.19	2.85	21.77	30.84
Body Condition Scores (1 – 5) (BCS)	15	2	0	2	2
Chest Girth, cm (CG)	15	71.21	3.34	63.50	73.66
Body Length (BL), cm	15	90.13	8.83	73.66	101
Shoulder Width, cm	15	45.38	4.27	38.100	53.34
Height at Withers (HTW), cm	15	61.299	4.17	50.80	66.04
Hip Width, cm	15	47.51	3.13	43.18	53.34
Scrotal Circumference (SC), cm	15	21.96	1.60	18	24

Table 3: Breed Differences in Body Conformation Traits Kiko vs. Anglo-Nubian Bucks (*P-values*)

Trait	P-values	Significance*
Body Weight, kg (BWT)	0.0000	**
Body Condition Scores (1 – 5) (BCS)	0.0000	**
Chest Girth, cm (CG)	0.0000	**
Body Length (BL), cm	0.0004	**
Shoulder Width, cm	0.0000	**
Height at Withers (HTW), cm	0.0000	**
Hip Width, cm	0.0000	**
Scrotal Circumference (SC), cm	0.0001	**

*Significant if $P \leq 0.05$

** Highly Significant if $P \leq 0.01$

Table 4: Hematological Profiles of Kiko Bucks (Mean ±SD)[1].

Item	Mean	Standard Deviation	Minimum	Maximum	Reference Value*
RBC (M/µl)	21.71	1.69	19.40	24.38	10.32 – 23.43
HCT %	41.64	8.91	27.10	55.800	22.0 – 39.0
HGB G/DL	10.94	1.14	9.10	12.400	8.9 – 13.8
MCV fL	19.25	4.23	12.30	25.40	14.0 – 22.3
MCH pg	5.04	0.43	4.20	5.80	5.0 – 7.0
MCHC g/dL	27.10	4.48	21.10	35.900	32.0 – 34.0
RETIC K/µL	0.88	1.91	0.00	7.10	0.0 – 15.0
WBC K/µL	10.93	2.38	9.03	16.23	6.03 – 19.58

NEU %	51.93	11.19	31.80	69.10	NA
LYM %	37.23	9.13	24.10	52.90	NA
MONO %	5.50	1.15	3.20	7.90	NA
EOS %	4.99	4.90	0.20	14.00	NA
BASO %	0.34	0.21	0.00	0.070	NA
NEU K/µL	5.85	2.45	3.05	10.63	1.72 – 10.61
LYM K/µL	3.94	0.73	2.69	5.26	2.68 – 11.54
MONO K/µL	0.59	0.17	0.45	1.11	0.06 – 0.89
EOS K/µL	0.50	0.48	0.030	1.44	0.03 – 1.29
BASO K/µL	0.036	0.022	0.00	0.070	0.00 – 0.24
PLT K/µL	764.93	228.60	383.00	1403.0	246 - 912
MPV fL	8.64	0.37	7.80	9.30	NA

* The Merck Veterinary Manual, seventh edition, (1991)

[1]RBC = Red Blood Cells, HCT= Hematocrit, HGB = Hemoglobin, MCV = Mean Cell Volume, MCH = Mean Cell Hemoglobin, MCHC = Mean Corpuscular Hemoglobin Concentration, RETICc= Red Blood Cells, WBC = White Blood Cells, NEU = Neutrophil, LYM = Lymphocytes, MONO = Mononucleosis, EOS = Eosinophil Count, BASO= Basophils, PLT= Number of Platetes, MPV = Mean Platelet Volume

* Merck Manual (1991)

Table 5: Hematological Profiles of Nubian Bucks (Mean ±SD).

Item	Mean	Standard Deviation	Minimum	Maximum	Reference Value*
RBC (M/µl)	17.99	1.88	15.43	22.16	10.32 – 23.43
HCT %	28.38	7.48	18.50	37.40	22.0 – 39.0
HGB G/DL	8.34	0.83	7.40	10.00	8.9 – 13.8
MCV Fl	16.10	4.91	9.30	22.90	14.0 – 22.3
MCH pg.	4.66	0.53	3.90	5.40	5.0 – 7.0
MCHC g/dL	30.94	6.73	23.20	42.40	32.0 – 34.0
RETIC K/µL	1.22	1.41	0.00	4.40	0.0 – 15.0
WBC K/µL	12.33	3.62	4.13	18.59	6.03 – 19.58
NEU %	42.68	9.93	29.00	64.50	NA
LYM %	49.51	8.73	31.50	65.90	NA
MONO %	7.49	3.15	2.10	13.10	NA
EOS %	1.08	0.80	0.30	3.00	NA
BASO %	0.42	0.54	0.00	1.90	NA
NEU K/µL	5.30	2.18	1.20	8.60	1.72 – 10.61
LYM K/µL	5.89	1.45	2.72	8.40	2.68 – 11.54
MONO K/µL	0.93	0.44	0.19	1.65	0.06 – 0.89
EOS K/µL	0.14	0.14	0.020	0.55	0.03 – 1.29
BASO K/µL	0.050	0.050	0.00	0.17	0.00 – 0.24
PLT K/µL	785.07	314.05	68.00	1277.0	246 – 912
MPV fL	8.02	0.35	7.40	8.60	NA

* The Merck Veterinary Manual, seventh edition, (1991)

[1]RBC = Red Blood Cells, HCT= Hematocrit, HGB = Hemoglobin, MCV = Mean Cell Volume, MCH = Mean Cell Hemoglobin, MCHC = Mean Corpuscular Hemoglobin Concentration, RETICc= Red Blood Cells, WBC = White Blood Cells, NEU = Neutrophil, LYM = Lymphocytes, MONO = Mononucleosis, EOS = Eosinophil Count, BASO= Basophils, PLT= Number of Platetes, MPV = Mean Platelet Volume

* Merck Manual (1991)

Table 6: Breed differences in Hematological Profiles of goats Bucks (Kiko vs. Nubian) – (*P- Values)*.

Item	P. Values	Significance
RBC(M/µl)	0.0000	**
HCT %	0.0001	**
HGB G/DL	0.0000	**
MCV Fl	0.0707	NS
MCH pg	0.0453	*
MCHC g/dL	0.0773	NS
RETIC K/µL	0.5926	NS
WBC K/µL	0.2200	NS
NEU %	0.0237	*
LYM %	0.0008	**
MONO %	0.0290	*
EOS %	0.0050	**
BASO %	0.5697	NS
NEU K/µL	0.5211	NS
LYM K/µL	0.0001	**
MONO K/µL	0.0102	**
EOS K/µL	0.0100	**
BASO K/µL	0.3568	NS
PLT K/µL	0.8423	NS

MPV fL	0.0001	**

[1]RBC = Red Blood Cells, HCT= Hematocrit, HGB = Hemoglobin, MCV = Mean Cell Volume, MCH = Mean Cell Hemoglobin, MCHC = Mean Corpuscular Hemoglobin Concentration, RETICc= Red Blood Cells, WBC = White Blood Cells, NEU = Neutrophil, LYM = Lymphocytes, MONO = Mononucleosis, EOS = Eosinophil Count, BASO= Basophils, PLT= Number of Platetes, MPV = Mean Platelet Volume
*Significant if $P \leq 0.05$
** Highly Significant if $P \leq 0.01$
NS= Not Significant

Table 7: Serum Biochemical Profiles of Kiko Bucks (Mean ±SD)[1].

Item	Mean	Standard Deviation	Minimum	Maximum	Reference Value*
GLU mg/DL	69.20	15.42	49.00	108.00	54 – 93
CREA mg/DL	0.80	0.12	0.60	1.00	0.6 – 1.4
BUN mg/DL	10.26	5.07	3.00	22.00	10 – 21
BUN/CREA	13.53	7.54	5.00	28.00	
CA mg/DL	8.48	0.77	7.30	9.60	8.2 – 9.8
TP g/Dl	7.56	0.71	6.60	9.30	6.4 – 7.8
ALT U/L	11.53	2.38	10.00	16.00	23 – 44
AST U/L	79.06	15.63	56.00	117.00	122 – 321
ALKP U/L	163.00	58.37	52.00	273.00	75 – 228
TBIL mg/Dl	0.39	0.17	0.10	0.70	0.1 – 0.3

* The Merck Veterinary Manual, seventh edition, (1991)
[1]GLU = Glucose, CREA = Creatinine, BUN = Blood Urea Nitrogen, CA = Calcium TP = Total Protein, ALT= Alkaline Aminotransferase, AST= Aspartate Aminotransferase, ALKP = Levels of Alkaline Phosphatase, TBIL = Total Bilirubin
* Merck Manual (1991)

Table 8: Serum Biochemical Profiles of Nubian Bucks (Mean ±SD)[1]

Item	Mean	Standard Deviation	Minimum	Maximum	Reference Value*
GLU mg/DL	68.80	7.18	59.00	88.00	54 – 93
CREA mg/DL	0.48	0.05	0.40	0.60	0.6 – 1.4
BUN mg/DL	13.60	3.77	4.00	19.00	10 – 21
BUN/CREA	28.33	8.26	8.00	43.00	
CA mg/DL	9.35	0.32	8.70	10.00	8.2 – 9.8
TP g/Dl	7.60	0.53	6.80	8.50	6.4 – 7.8
ALT U/L	17.73	4.89	10.00	26.00	23 – 44
AST U/L	111.80	13.88	84.00	136.00	122 – 321
ALKP U/L	243.60	53.60	147.00	353.00	75 – 228
TBIL mg/Dl	0.42	0.29	0.10	0.90	0.1 – 0.3

* The Merck Veterinary Manual, seventh edition, (1991)
[1]GLU = Glucose, CREA = Creatinine, BUN = Blood Urea Nitrogen, CA = Calcium TP = Total Protein, ALT= Alkaline Aminotransferase, AST= Aspartate Aminotransferase, ALKP = Levels of Alkaline Phosphatase, TBIL = Total Bilirubin
* Merck Manual (1991)

Table 9: Breed differences in Serum Biochemical Profiles of goats Bucks (Kiko vs. Nubian)[1] (P- Values)

Item	P. Values	Significance
GLU mg/DL	0.9281	NS
CREA mg/DL	0.0000	**
BUN mg/DL	0.0509	NS
BUN/CREA	0.0000	**
CA mg/DL	0.0004	**
TP g/Dl	0.8407	NS
ALT U/L	0.0001	**
AST U/L	0.0000	**
ALKP U/L	0.0005	**
TBIL mg/Dl	0.7660	NS

*Significant if $P \leq 0.05$
** Highly Significant if $P \leq 0.01$
[1]GLU = Glucose, CREA = Creatinine, BUN = Blood Urea Nitrogen, CA = Calcium TP = Total Protein, ALT= Alkaline Aminotrnasferase, AST= Aspartate Aminotransferase, ALKP = Levels of Alkaline Phosphatase, TBIL = Total Bilirubin

Table 10: Phenotypic Correlations Coefficient *(r)* between Body Conformation Traits and Blood Hematology in Nubian and Kiko Goats[1]

Parameter	*r*	Parameter	*r*
Nubian		**Kiko**	
BWT vs. WBC	-0.34	BCS vs. WBC	-0.26
BWT vs. RBC	0.73	BCS vs. RBC	0.63
BWT vs. PLT	-0.13	BCS vs. PLT	-0.11
BWT vs. MONO	-0.55	BCS vs. MONO	-0.43
BWT vs. MCHC	-0.36	BCS vs. MCHC	-0.23
BWT vs. MCH	0.41	BCS vs. MCH	0.27
BWT vs. EOS	0.50	BCS vs. EOS	0.42
BWT vs. MPV	0.61	BCS vs. MPV	0.64
BWT vs. MCV	0.37	BCS vs. MCV	0.25
BWT vs. NEU	0.19	BCS vs. NEU	0.27
BWT vs. HCT	0.66	BCS vs. HCT	0.52
BWT vs. BASO	-0.08	BCS vs. BASO	-0.17
BWT vs. LYM	-0.38	BCS vs. LYM	-0.36
BWT vs. RETIC	-0.07	BCS vs. RETIC	-0.02
BWT vs. HGB	0.86	BCS vs. HGB	0.65
HTW vs. WBC	-0.44	BL vs. WBC	-0.40
HTW vs. RBC	0.55	BL vs. RBC	0.01
HTW vs. PLT	-0.10	BL vs. PLT	-0.36
HTW vs. MONO	-0.44	BL vs. MONO	-0.31
HTW vs. MCHC	-0.47	BL vs. MCHC	0.29
HTW vs. MCH	0.51	BL vs. MCH	0.23
HTW vs. EOS	0.30	BL vs. EOS	0.72
HTW vs. MPV	0.44	BL vs. MPV	0.34
HTW vs. MCV	0.46	BL vs. MCV	0.03
HTW vs. NEU	0.01	BL vs. NEU	0.54
HTW vs. HCT	0.66	BL vs. HCT	0.09
HTW vs. BASO	-0.06	BL vs. BASO	-0.18
HTW vs. LYM	-0.18	BL vs. LYM	0.05
HTW vs. RETIC	-0.04	BL vs. RETIC	-0.23
HTW vs. HGB	0.74	BL vs. HGB	0.58

[1]BWT = Body weight, HTW = Height at Withers, RBC = Red Blood Cells, HCT= Hematocrit, HGB = Hemoglobin, MCV = Mean Cell Volume, MCH = Mean Cell Hemoglobin, MCHC = Mean Corpuscular Hemoglobin Concentration, RETICc= Red Blood Cells, WBC = White Blood Cells, NEU = Neutrophil, LYM = Lymphocytes, MONO = Mononucleosis, EOS = Eosinophil Count, BASO= Basophils, PLT= Number of Platetes, MPV = Mean Platelet Volume

Table 11: Phenotypic Correlations Coefficient *(r)* between Body Conformation Traits and Serum Biochemistry in Nubian and Kiko Goats1

Parameter	*r*	Parameter	*r*
Nubian		**Kiko**	
BWT vs. ALKP	-0.50	BCS vs. ALKP	-0.52
BWT vs. ALT	-0.53	BCS vs. ALT	-0.52
BWT vs. AST	-0.61	BCS vs. AST	-0.58
BWT vs. BUN	-0.31	BCS vs. BUN	-0.39
BWT vs. CREA	0.87	BCS vs. CREA	0.79
BWT vs. GLU	-0.23	BCS vs. GLU	-0.16
BWT vs. TBIL	-0.12	BCS vs. TBIL	-0.24
BWT vs. TP	-0.20	BCS vs. TP	-0.36
BWT vs. CA	-0.68	BCS vs. CA	-0.66
HTW vs. ALKP	-0.48	BL vs. ALKP	-0.32
HTW vs. ALT	-0.54	BL vs. ALT	-0.44
HTW vs. AST	-0.52	BL vs. AST	-0.22
HTW vs. BUN	-018	BL vs. BUN	-0.30
HTW vs. CREA	0.68	BL vs. CREA	0.59
HTW vs. GLU	-0.25	BL vs. GLU	-0.16
HTW vs. TBIL	-0.24	BL vs. TBIL	0.02
HTW vs. TP	-0.25	BL vs. TP	0.04
HTW vs. CA	-0.57	BL vs. CA	-0.49

[1]BWT = Body weight, HTW = Height at Withers, GLU = Glucose, CREA = Creatinine, BUN = Blood Urea Nitrogen, CA = Calcium TP = Total Protein, ALT= Alkaline Aminotransferase, AST= Aspartate Aminotransferase, ALKP = Levels of Alkaline Phosphatase, TBIL = Total Bilirubin.

Conclusions

The components of the hematological and serum biochemical parameters in Kiko and Nubian bucks in this study seem to point out some differences from those obtained for other ruminant species. The observed differences further support the fact that the physiological parameters reported for other ruminant animals may not be applied on Kiko and Nubian goats kept in this ecological zone.

Breed was observed to have a significant effect on parameters like HGB, RBC and HCT values. Breed was also observed to

have effect on the lymphocytes and Neutrophils, where the Kiko goats had increased lymphocyte values compared to the Nubian bucks. It may be concluded that the biochemical and hematological parameters were mostly within the physiological range for goats as reported from previous studies. These data will contribute to our knowledge for monitoring health status, diagnosis of diseases and management in the Kiko and Nubian breeds of goat under semi-intensive pasture production system in southeast Alabama. This study is considered as preliminary study that can be used as a reference for further studies to determine reference values for the studied breeds to aid the veterinarians in the interpretation of the laboratory data and for the selection of the appropriate treatment.

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