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Research Article

Seasonal Variations in Hematological and Serum Biochemical Parameters in Kiko Meat Goats under Semi-Intensive Management Systems

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Abstract

Hematological and serum biochemical profiles have been used in several species of domestic livestock to monitor herd health. Application of this technique to meat goats in semi-intensive production systems has been limited by a lack of suitable reference ranges for most of these parameters. Mature Kiko meat goats (n =15; age = 9-12 months) were utilized to determine the effects of season on biochemical parameters and hematology profiles. Metrological data (rainfall, diurnal temperature and relative humidity) were also collected. For hematological profiles, non-significant seasonal differences were observed in hemoglobin (HGB) values of 9.67 ± 0.75 9.23 ± 1.478,82 ± 1.21 and 9.99 ± 1.59 G/DL P ≥ 0.05 for spring, summer, fall and winter respectively. Red Blood Cells (RBC) were significantly affected (P ≤ 0.05) by season of collection16.7 ± 4.12, 18.1 ± 2.52 18.0 ± 1.58 and 20.5 ± 4.27 M/μl for spring, summer, fall and winter respectively. Also, White Blood Cells (WBC) showed non- significant seasonal variations (P ≥ 0.05) 15.04 ± 3.53, 15.9 ± 6.4714.3 ± 5.02, and 14.8 ± 6.59 K/μL for spring, summer, fall and winter respectively. However, highly significant (P ≤ 0.01) seasonal differences were observed Reticulocytes (RETIC) K/μL 3.76 ± 2.29, 1.34 ± 2.0, 0.90 ± 1.26 and 1.56 ± 1.49 for spring, summer, fall and winter respectively. Serum biochemical parameters showed non- significant blood glucose values of 65.0 ± 6.2 62.7 ± 6.2. 60.0 ± 16.6 and 57.8 ± 11.8 mg/dL P ≥ 0.05 for spring, summer, fall and winter respectively. Blood urea nitrogen (BUN mg/DL), Calcium (CA mg/DL) and Alkaline Aminotransferase ALT U/L showed a high significant seasonal variation (P ≤ 0.01). The hematological and serum biochemical values obtained in this study will further underlined the need to establish appropriate physiological baseline values for meat goats 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 goats among limited resource producers.

Keywords: Blood serum biochemistry; Hematology; Kiko meat goats; Seasons

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Abbreviations

BWT: Body Weight

BCS: Body Condition Score

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

RBC: Red Blood Cells

HCT: Hematocrit

HGB: Hemoglobin

MCV: Mean Cell Volume

MCH: Mean Cell Hemoglobin

MCHC: Mean Corpuscular Hemoglobin Concentration

RETIC: Reticulocytes

WBC: White Blood Cells

NEU: Neutrophil

LYM: Lymphocytes

MONO: Monocytes

EOS: Eosinophil Count

BASO: Basophils

PLT: Number of Platelets

MPV: Mean Platelet Volume

Introduction

Goats are important for both commercial and subsistent farming systems in rural southeastern United States. Limited resource producers keep goats primarily for meat and as a source of income since most subsistent farmers cannot afford to keep cattle. Goats are very versatile because not only do they provide goods but they also provide services such as vegetation management by eating unwanted vegetation in fields, and they can also prevent fuel fires by reducing fuel load [1]. The tremendous changes in demand that are ongoing within rural farm communities in the course of the last two decades has created the opportunity for goat production to become widespread [2]. Also, the substantial increase in the U.S. chevon imports in recent years, provided reasons for growth in the domestic meat-goat industry [3].

The Kiko goat is a composite breed developed in humid New Zealand in the 1970s and 1980s for improved growth and survivability by crossing Saanen, Toggenburg, and Nubian bucks with selected feral does. The Kiko is thought to be a vigorous, hardy, large frame, and early maturing animal that doesn't need pampering [4]. In the southeastern U.S., efficient meat 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 [5]. The Southeastern region is more favorable for Kiko breed of goats due to their increased parasitic resistance and lower incidence of hoof problems [6]. Moreover, the Kiko goat breed focuses heavily on the production of goat meat while maintaining minimal intervention inputs.Environmental conditions and in particular seasonal variations in air temperature and relative humidity are considered physiological stressors which affect the animal's biological system [7]. The variation in environmental variables such as ambient temperature, relative humidity, wind and rainfall were recognized as the potential hazards in livestock growth and production. In order to maintain homoeothermic, an animal must be in thermal equilibrium with its environment, which includes radiation, air temperature, air movement and humidity [8].

Both serum biochemical and hematological profiles can be influenced by a number of factors such as age [9], physiological status [10, 11]. Biochemical and hematological parameters change in different seasons and temperature, humidity index may also be a factor in these fluctuations [12]. Reported elevations in lymphocytes, and phagocytic activities in Dhofari goat during the summer season, while a decrease in levels of neutrophils occurred in the winter season. [13] Reported that India Bengal goats express higher levels of hemoglobin, packed cell volume, mean corpuscular volume as well as mean corpuscular hemoglobin [14]. Reported that during the summer monsoon season, India Bengal goats showed higher levels of hemoglobin, packed cell volume, mean corpuscular volume as well as mean corpuscular hemoglobin [15,13], observed that ambient temperature and temperature humidity index have effects on both hematological and biochemical parameters in goats with total protein, blood urea nitrogen, and albumin significantly ($P<0.01$) higher in summer than in both winter and autumn months [16], Observed that in goats, summer season resulted in increases in levels of blood urea nitrogen, uric acid as well as creatinine. However other parameters such as calcium, cholesterol, glucose and inorganic phosphorus decreased during the summer months. While seasonal variations are extremely important to note, other environmental factors are equally important factors when analyzing and determining hematological and biochemical parameters of meat goats breeds. It may be possible that blood values are also affected by both water temperature, and/or the differences between intensive and extensive production systems [17]. To date, very few hematological and serum biochemistry parameters for Kiko (meat) and their relationships to seasons of the year under semi-intensive management system have been published. The hematological and serum biochemical values obtained in this study will further underlined the need to establish appropriate physiological baseline values for Kiko meat goats in Alabama which could help in the realistic evaluation of management practice, nutrition, diagnosis of health as well as in determining the physiological status of goats used by limited resource producers. In addition, this study will provide insights into physiological responses of the Kiko meat goat to different seasons, allowing producers to better evaluate its ability to adapt and cope with various environmental stressors.

The objective of the present project was to investigate seasonal (spring, summer, fall, and winter) influences on the biochemical and hematological parameters of Kiko-meat goats managed under semi-intensive production system in southeast Alabama.

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 meters above sea level and has an annual precipitation amount of 1222mm. The Tuskegee University Animal Care and Use Committee approved the herd management protocol used.

in this project. For this project a total number of 15 Kiko goats that were semi-intensively managed in summer, fall, winter and spring were utilized. Goats were between the ages of 1 and 2 years old and were dewormed three times during the research period. All animals were managed on tall fescue (Festuca arundinacea) and Bermuda grass (Cynodondactylon) pastures and supplemented with Bermuda grass 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 blocks. All research animals had access to water daily.

Blood collection

Blood samples were collected between 8:00AM and 10:00AM once a week for three weeks for each of the calendar seasons, summer, fall, Winter and Spring. Blood samples were collected with an 18-gauge needle by jugular venipuncture. The blood was collected into two tubes, one in a plain tube for serum analysis and another with EDTA for whole blood analysis. A total of 5 mL of blood was collected per collection. Blood samples were centrifuged within two hours of collection and serum was harvested and stored at -20°C for biochemical analysis. During each collection period temperature, humidity and rainfall were also recorded.

Hematology

Samples for blood hematology was prepared by using a special blood analysis buffer approved for goat hematology (Concentrated

Lysing Reagent, SEACa and Florence, Italy). All samples were analyzed within 45 minutes after collection by using IDEXX Procyte Dx Automated Hematology Analyzer for total White Blood Cells (WBC), Red Blood Cells (RBCS) Hemoglobin HGB), hematocrit (HCT), Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH), Mean Corpuscular Hemoglobin Concentration (MCHC) and Number of Platelets (PLT). All samples were analyzed at the Tuskegee University College of veterinary medicine clinical pathology diagnostic laboratory.

Serum biochemistry

Blood samples were left to clot and then centrifuged at 3000 rpm for 15 minutes, and then the serum was collected. The serum was kept frozen at -20°C until it was used for the biochemical analysis. The serum biochemistry was carried out using IDEXX Catalyst One Automated Chemistry Analyzer for Blood Urea Nitrogen (BUN) Asparate aminotransferase (AST), Alanine Aminotransferase (ALT), Alkaline Phosphatase (ALP), Glucose (GLU), Creatinine (CREA), Calcium (CA) Total Protein (TP), and Total Bilirubin (TBIL). All samples were analyzed at the Tuskegee University College of veterinary medicine clinical pathology diagnostic laboratory.

Body weight and body condition score

Body weight was recorded using a digital scale. In addition to assessing body condition, a palpable body condition scoring scale was also used on a scale of 1 to 5, (1 being emaciated and 5 being obese). Body condition scoring was subjectively determined. Body weight was taken each time blood collections occurred for consistent values.

Environmental conditions

The mean values of daily and cumulative rainfall, rainy days, relative humidity, and minimum, maximum temperature and average summer fall, winter and spring seasons are shown in (Table 1.)

Item	Season	Mean	SD	Minimum	Maximum
Temperature at Collection °C	Spring	13.3	2.55	11.1	16.1
	Summer	23.6	2.50	21.1	26.1
	Fall	13.8	8.61	8.88	23.8
	Winter	6.08	11.2	-2.7	18.8
High °C	Spring	25.7	3.59	21.6	28.3
	Summer	32.9	1.15	31.6	33.8
	Fall	23.6	1.27	22.2	24.4
	Winter	16.07	7.85	7.22	22.2
Low °C	Spring	10.1	0.28	10.0	10.5
	Summer	21.1	1.61	19.4	22.2
	Fall	6.47	2.31	3.88	8.33
	Winter	4.98	10.5	-3.88	16.6
Humidity%	Spring	71.6	18.1	55.0	91.0
	Summer	83.3	7.63	75.0	90.0
	Fall	88.0	8.0	80.0	96.0
	Winter	82.0	21.6	57.0	95.0
Rainfall cm	Spring	0.00	0.00	0.00	0.00
	Summer	0.02	0.04	0.00	0.07
	Fall	0.00	0.00	0.00	0.00
	Winter	0.87	1.51	0.00	2.61

Table 1: Environmental Conditions.

Statistical analysis

All results are expressed as ± Standard Deviation (SD) [18]. Statistical software calculated the minimum and maximum values to determine the range, mean, and standard deviation of the mean. The effects of season on biochemical parameters and hematological profiles of goats were Analyzed by an Analysis of Variance (ANOVA) using [18], statistical software.

Results and discussion

Body weight, body condition score and serum biochemical parameters

Body weight of 59.9 kg ± 11.7 kg was recorded for spring, 46.2 kg ±11.4 kg in summer, 46.3 kg ± 13.6 kg, in fall, and 46.5 kg ± 10.1 kg in winter respectively. For body condition scores, results show 3.0 ± 0.0 in the spring, 2.7 ± 0.4 in the summer, 2.6 ± 0.5 in the fall, and 2.6 ± 0.5 in the winter respectively. Seasonal values for the following serum biochemical parameters 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 are presented in (Table 2).

Item	Season	Mean	SD	Minimum	Maximum
Temperature at Collection °C	Spring	13.3	2.55	11.1	16.1
	Summer	23.6	2.50	21.1	26.1
	Fall	13.8	8.61	8.88	23.8
	Winter	6.08	11.2	-2.7	18.8
High °C	Spring	25.7	3.59	21.6	28.3
	Summer	32.9	1.15	31.6	33.8
	Fall	23.6	1.27	22.2	24.4
	Winter	16.07	7.85	7.22	22.2
Low °C	Spring	10.1	0.28	10.0	10.5
	Summer	21.1	1.61	19.4	22.2
	Fall	6.47	2.31	3.88	8.33
	Winter	4.98	10.5	-3.88	16.6
Humidity%	Spring	71.6	18.1	55.0	91.0
	Summer	83.3	7.63	75.0	90.0
	Fall	88.0	8.0	80.0	96.0
	Winter	82.0	21.6	57.0	95.0
Rainfall cm	Spring	0.00	0.00	0.00	0.00
	Summer	0.02	0.04	0.00	0.07
	Fall	0.00	0.00	0.00	0.00
	Winter	0.87	1.51	0.00	2.61

Table 2: Descriptive statistics for seasonal serum biochemical profiles1 of kiko meatgoats.

1GLU = 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

These results were compared with values obtained from other goat breeds [19] and the reference range for goats as reported by [20]. GLU levels of 65.0 ±14.9, 62.7 ± 6.2, 60.6 ± 16.6 and 57.8 ± 11.3 mg/DL were obtained for spring, summer, fall and winter seasons respectively. CREA values were 0.52 ± 0.07, 0.54 ± 0.15, 0.62 ± 0.16 0.63 ± 0.09 mg/DL for spring, summer, fall and winter seasons respectively. Mean values of 15.6 ± 4.18, 15.8 ± 5.17, 12.4 ± 3.7 and 9.3 ± 4.02 mg/DL for BUN in spring, summer, fall and winter seasons respectively. Lower values of TBIL, BUN were found in Kiko goat breeds when compared to values from other goat breeds [21]. Lower concentration of BUN is an indication of the dietary protein level or liver chronic diseases [22]. Mean values of 8.2 ± 0.6, 9.1 ± 0.6, 8.4 ±1.1 and 8.4 ± 0.5 mg/DL were recorded for CA in spring, summer, fall and winter seasons respectively. TP values of 7.1± 0.5, 7.8 ± 0.7, 7.6 ± 0.9 and 7.8 ± 0.5 g/Dl were obtained in spring, summer, fall and winter seasons respectively. In addition, levels of ALKP were 90.8 ± 58.3, 97.9 ± 59.3, 47.8 ±17.1 and 80.0 ± 30.7 in spring, summer, fall and winter seasons respectively. TBIL, AST, GLU and CREA levels were not significantly affected by seasons ($P \geq 0.05$). CA and BUN levels were highly significantly influenced by seasons ($P \leq 0.01$). Total protein and alkaline phosphatase levels showed significant seasonal variations ($P \leq 0.05$) as shown in (Table 3).

TRAIT	SEASON				P-values	Significance
	SPRING	SUMMER	FALL	WINTER		
GLU mg/DL	65.0 ± 14.9	62.7 ± 6.2	60.6 ± 16.6	57.8 ± 11.8	0.49	NS
CREA mg/DL	0.52 ± 0.07	0.54 ±0.15	0.62 ± 0.16	0.63 ± 0.09	0.06	NS
BUN mg/DL	15.6 ± 4.1	15.8 ± 5.1	12.4 ± 3.7	9.3 ± 4.02	0.009	**
BUN/CREA	30.6 ± 10.6	30.8 ± 11.0	21.6 ± 8.1	15.8 ± 6.6	0.001	**
CA mg/DL	8.2 ± 0.6	9.1 ± 0.6	8.4 ± 1.1	8.4 ± 0.5	0.008	**
TP g/Dl	7.1 ± 0.5	7.8 ± 0.7	7.6 ± 0.9	7.8 ± 0.5	0.016	*
ALT U/L	11.6 ± 2.1	19.2 ± 6.2	12.8 ± 5.6	11.2 ± 3.6	0.001	**
AST U/L	99.6 ± 30.7	87.5 ± 18.4	78.6 ± 11.8	83.2 ± 28.0	0.94	NS
ALKP U/L	90.8 ± 58.3	97.9 ± 59.3	47.8 ± 17.1	80.0 ± 30.7	0.018	*
TBIL mg/Dl	0.46 ± 0.15	0.50 ± 0.09	0.38 ± 0.22	0.39 ± 0.21	0.210	NS

Table 3: Seasonal differences in serum biochemical1 profiles of kiko meat goats (p- values).

*Significant if $P \leq 0.05$,** Highly Significant if $P \leq 0.01$,***NS = Not Significant

Our study showed a moderate increase in total protein and globulin which is associated with the rise in ambient summer temperature [23]. Suggested that any such increase in serum protein could be a physiological attempt to maintain extended plasma volume. Variations in serum protein concentration were observed in lactating cattle and buffaloes during spring and summer seasons [24]. The values of creatinine in the current study did not increase under high environmental temperatures in summer suggesting that the Kiko meat goats are metabolically adapted to hot and humid conditions of southeast Alabama. In the present study blood urea values were higher at highest temperatures in summer months, confirming results obtained [25], could be attributed to an increased utilization of amino acids as energy source in hot humid conditions.

Determination of serum total bilirubin is valuable for the diagnosis of fatty liver in ruminants. Total bilirubin is often increased after parturition [26] and is also increased during periods of anorexia [27]. The results of our study showed lower ALP values than that reported in Sokoto red, Sahel and Saanen goats [28]. However, our ALP values were slightly higher than that reported in West African Dwarf (WAD) goats [29]. ALP 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 [28].

Hematology

Mean values and standard deviations for RBC = Red Blood Cells, HCT= Hematocrit, HGB = Hemoglobin, MCV = Mean Cell Volume, MCH = Mean Cell Hemoglobin, MCHC = Mean Corpuscular Hemoglobin Concentration, RETIC= Reticulocytes, WBC = White Blood Cells, NEU = Neutrophil, LYM = Lymphocytes, MONO = Monocytes, EOS = Eosinophil Count, BASO= Basophils, PLT= Number of Platelets, MPV = Mean Platelet Volume in the summer, fall, winter and spring seasons are shown in (table 4). The average values obtained in this study for RBC, PCV, HGB, MCV, MCH, MCHC are within the reference ranges for the caprine species (table 4). The mean RBC varied in all seasons from a mean low count of 16.7 ± 4.12 M/µl in spring to a mean high count of 20.5 ± 4.27 M/µl in winter. These differences were significant ($P \leq 0.05$) (table 5). Also, values of RBC, HGB, and HCT in our study were within the normal range for goats as reported by [30], similar to those observed in Barbari Black Aardi breed of goats [31]. In contrast, the values of RBCs, HGB, and HCT were higher than that reported in the Damascus breed [30]. Higher values of MCV and MCH and lower values of MCHC were observed in the Kiko goat breed comparing to that in the other goat breeds [28], as shown in (Table 4**).**

Item	Season	Mean	Standard Deviation	Minimum	Maximum	Reference Value
RBC(M/µl)	Spring	16.7	4.12	12.5	23.5	
	Summer	18.1	2.52	14.3	22.2	
	Fall	18.0	1.58	15.6	21.3	
	Winter	20.5	4.27	16.1	28.0	
						10.32-23.43

HCT %	**Spring**	36.1	7.3	23.0	45.4	
	Summer	29.0	9.8	16.0	46.7	
	Fall	27.2	9.4	13.7	41.4	
	Winter	32.3	11.3	11.1	51.4	
						22.0-39.0
HGB G/DL	**Spring**	9.6	0.75	8.5	10.9	
	Summer	9.2	1.4	7.1	11.5	
	Fall	8.8	1.2	6.5	10.8	
	Winter	9.9	1.5	8.2	13.7	
						8.9-13.8
MCV fL	**Spring**	23.5	8.7	10.9	32.6	
	Summer	16.2	5.3	7.6	24.4	
	Fall	15.0	4.9	8.3	20.9	
	Winter	16.3	5.7	4.9	23.7	
						14.0-22.3
MCH pg	**Spring**	6.0	1.0	4.4	7.3	
	Summer	5.1	0.64	4.1	6.2	
	Fall	4.8	0.58	4.0	5.7	
	Winter	4.9	0.76	3.8	6.2	
						5.0-7.0
MCHC g/dL	**Spring**	28.2	8.1	21.6	40.9	
	Summer	34.3	9.8	24.6	53.8	
	Fall	35.2	9.0	26.1	48.9	
	Winter	35.1	15.4	20.2	78.4	
						32.0-34.0
RETIC K/µL	**Spring**	0.01	0.03	0.00	0.1	
	Summer	0.00	0.00	0.00	0.00	
	Fall	0.00	0.00	0.00	0.00	
	Winter	0.00	0.00	0.00	0.00	
						0.0-15.0
WBC K/µL	**Spring**	15.0	3.5	10.7	25.7	
	Summer	15.9	6.4	7.9	28.3	
	Fall	14.3	5.0	7.4	22.0	
	Winter	14.8	6.5	7.1	29.3	
						N/A
NEU %	**Spring**	53.8	15.2	26.9	71.2	
	Summer	39.7	11.1	22.2	58.7	
	Fall	44.5	5.1	32.71	58.2	
	Winter	42.5	7.9	30.9	55.4	
						N/A
LYM %	**Spring**	36.7	10.9	25.7	58.8	
	Summer	44.3	6.8	31.6	56.6	
	Fall	37.7	5.8	23.8	47.9	
	Winter	41.4	5.1	34.9	54.3	
						N/A
MONO %	**Spring**	4.4	3.5	0.2	9.9	
	Summer	7.8	4.5	1.7	16.1	
	Fall	8.9	3.2	3.8	15.7	
	Winter	7.7	3.5	3.3	14.9	
						N/A
EOS %	**Spring**	4.1	2.8	0.6	8.7	
	Summer	7.6	4.3	2.7	14.8	
	Fall	8.5	5.4	1.2	19.4	
	Winter	7.7	3.9	1.4	14.7	
						N/A
BASO %	**Spring**	0.75	0.35	0.1	1.2	
	Summer	0.42	0.28	0.1	1.10	
	Fall	0.24	0.16	0.00	0.60	
	Winter	0.42	0.28	0.10	1.10	
						N/A
NEU K/µL	**Spring**	8.0	2.9	4.2	16.5	
	Summer	5.9	1.9	3.3	8.9	
	Fall	6.3	2.6	2.7	10.9	
	Winter	6.2	3.3	3.1	16.2	
						1.72-10.61
LYM K/µL	**Spring**	5.5	2.02	3.2	9.3	
	Summer	7.2	3.1	2.5	12.4	
	Fall	5.3	1.8	2.9	7.7	
	Winter	6.2	3.1	2.7	12.7	
						2.68-11.54
MONO K/µL	**Spring**	0.63	0.50	0.04	1.4	
	Summer	1.3	1.04	0.20	3.2	
	Fall	1.30	0.65	0.36	2.3	
	Winter	1.1	0.68	0.34	2.1	
						0.06-0.89
EOS K/µL	**Spring**	0.68	0.58	0.08	2.05	
	Summer	1.4	1.3	0.29	4.1	
	Fall	1.2	1.08	0.22	4.10	
	Winter	1.08	0.76	0.24	3.5	
						0.03-1.29
BASO K/µL	**Spring**	**0.11**	**0.07**	**0.01**	**0.32**	
	Summer	0.06	0.03	0.02	0.15	
	Fall	0.03	0.02	0.00	0.07	
	Winter	0.06	0.04	0.02	0.17	
						0.00-0.24
PLT K/µL	**Spring**	641.6	167.4	322.0	906.0	
	Summer	591.4	143.7	329.0	822.0	
	Fall	749.6	248.4	527.0	1517.0	
	Winter	645.5	249.5	136.0	1116.0	
						246-912
MPV fL	**Spring**	7.8	0.3	7.1	8.3	
	Summer	7.8	0.3	7.1	8.3	
	Fall	7.9	0.4	7.0	8.4	
	Winter	8.2	0.3	7.6	8.7	
						N/A

Table 4: Descriptive statistics for seasonal hematological profiles1 of kiko meat goats.

1 RBC = Red Blood Cells, HCT= Hematocrit, HGB = Hemoglobin, MCV = Mean Cell Volume,

MCH = Mean Cell Hemoglobin, MCHC = Mean Corpuscular Hemoglobin Concentration, RETIC= Reticulocytes, WBC = White Blood Cells, NEU = Neutrophil, LYM = Lymphocytes, MONO =Monocytes, EOS = Eosinophil Count, BASO= Basophils, PLT= Number of Platelets, MPV = Mean Platelet Volume.

TRAIT	SEASON				P-values	Significance
	SPRING	SUMMER	FALL	WINTER		
RBC(M/μl)	16.7 ± 4.12	18.1 ± 2.52	18.0 ± 1.58	20.5 ± 4.27	0.0269	*
HCT %	36.1 ± 7.39	29.0 ± 9.86	27.2 ± 9.43	32.3 ± 11.3	0.0671	NS
HGB G/DL	9.67 ± 0.75	9.23 ± 1.47	8.82 ± 1.21	9.99 ± 1.59	0.0870	NS
MCV fL	23.5 ± 8.72	16.2 ± 5.37	15.0 ± 4.97	16.3 ± 5.76	0.0022	**
MCH pg	6.00 ± 1.03	5.10 ± 0.64	4.87 ± 0.58	4.96 ± 0.76	0.0006	**
MCHC g/dL	28.6 ± 8.12	34.3 ± 9.82	35.2 ± 9.07	35.1 ± 15.4	0.2559	NS
RETIC K/μL	3.76 ± 2.29	1.34 ± 2.02	0.90 ± 1.26	1.56 ± 1.49	0.0003	**
WBC K/μL	15.04 ± 3.53	15.9 ± 6.47	14.3 ± 5.02	14.8 ± 6.59	0.8694	NS
NEU %	8.05 ± 2.99	5.94 ± 1.98	6.38 ± 2.60	6.27 ± 3.31	0.1678	NS
LYM %	36.7 ± 10.9	44.3 ± 6.84	37.7 ± 5.87	41.4 ± 5.17	0.0294	*
MONO %	4.48 ± 3.50	7.82 ± 4.54	8.91 ± 3.29	7.74 ± 3.54	0.0135	*
EOS %	0.68 ± 0.58	1.41 ± 1.33	1.25 ± 1.08	1.08 ± 0.76	0.2229	NS
BASO %	0.70 ± 0.35	0.42 ± 0.28	0.24 ± 0.16	0.44 ± 0.23	0.0002	**
LYM K/μL	5.54 ± 2.02	7.22 ± 3.15	5.32 ± 1.86	6.26 ± 3.12	0.1973	NS
MONO K/μL	0.63 ± 0.50	1.34 ±1.04	1.30 ± 0.65	1.15 ± 0.68	0.448	NS
EOS K/μL	0.68 ± 0.58	1.41 ± 1.33	1.25 ± 1.08	1.08 ± 0.76	0.2229	NS
BASO K/μL	0.11 ± 0.07	0.06 ± 0.03	0.03 ± 0.02	0.06 ± 0.04	0.0009	**
PLT K/μL	641.6 ± 167.4	591.4 ± 143.7	749.6 ± 248.1	645.5 ± 248.5	0.2142	NS
MPV fL	7.81 ± 0.35	7.80 ± 0.33	7.92 ± 0.43	8.22 ± 0.35	0.0090	**

Table 5: Seasonal differences in hematological profiles 1 of kiko meat goats (p- values)

*Significant if P ≤ 0.05,** Highly Significant if P ≤ 0.01,***NS = Not Significant

1 RBC = Red Blood Cells, HCT=Hematocrit, HGB = Hemoglobin, MCV =Mean Cell Volume, MCH = Mean Cell Hemoglobin, MCHC = Mean Corpuscular Hemoglobin Concentration, RETIC= Reticulocytes, WBC =22 White Blood Cells, NEU = Neutrophils, LYM = Lymphocytes, MONO = Monocytes, EOS = Eosinophil Count,BASO= Basophils, PLT= Number of Platelets MPV = Mean Platelet Volume

As shown in (tables 4&5) the mean HGB concentration decreased slightly between winter and spring (9.9 ±1.5 vs. 9.6 ± 0.75 G/DL), however, no significant seasonal differences were observed (P ≤ 0.05). Between spring and winter, the mean HCT increased slightly (36.1 ± 7.39 vs. 32.3 ± 11.3%). Intermediate values were found in fall and summer (27.2 ±9.43 vs. 29.0 ± 9.86%) respectively. These differences were not significant (P ≥ 0.05). The Mean Corpuscular Hemoglobin Concentration (MCHC) has a reference value of 32.0-34.0 g/dL for goats [30]. MCHC increased from 28.6 ± 8.12 g/dL in spring to reach the highest value of 35.2 ± 9.07 g/dL in the fall. There were fluctuating variations throughout all four season thus indicating seasonal influence, however, the values obtained may represent possible iron deficiency in diets consumed by these goats. The decrease levels of the MCHC, especially during the fall and winter season, may also be indicative of a parasitic infection.

Highly significant seasonal differences (P ≤ 0.01) were observed for both mean corpuscular volume and mean cell hemoglobin (23.5 ± 8.72, 16.2 ± 5.37, 15.0 ± 4.97 and 16.3 ± 5.76 fl) (6.00 ±1.03, 5.10 ± 0.64, 4.87 ± 0.58 and 4.96 ± 0.76 pg for spring, summer fall and winter respectively. Results from the current show that the (MCV) and (MCH) were significantly lower in winter compared to values obtained in spring. The lowest MCV (15.0 ± 4.97fl) was obtained in fall. This low (MCV) value could be related to the negative correlation between size and number of erythrocytes as suggested [32]. The values obtained in the present study for (MCV) and (MCH) during winter and wet summer were not in general agreement with other findings [33], who reported high values of (MCV) and (MCH) in cold dry environment compared to values in hot humid conditions. Non-significant seasonal changes (P ≥ 0.05) in total leucocyte count (WBC) were found (15.04 ± 3.53, 15.9 ± 6.47, 14.3 ± 5.02 and 14.8 ± 6.59 K/μL) for spring, summer, fall and winter respectively. The present results for seasonal changes in erythrocyte count and (HGB) concentration in Kiko goats are in agreement with the findings in other breeds of goats [33,34], reported higher values of erythrocyte count, (PCV) and (HGB) during summer compared to winter months. These variations between Kiko and other breeds of goats may be attributed to differences in environmental conditions as well as nutritional factors [35]. Reported lower values of these indices in winter for Cameroon goats kept in temperate environment and attributed that to the change in diet. The effect that seasonality can have on WBC count is attributed, among other factors to the stress associated with the cold in winter, leading to suppression of the immune response [34,36], reported that elevation of WBC in winter occurs because the lymphoid organs tend to become larger in colder seasons. Our results show that the Kiko goats had higher WBCs and neutrophils percentage compared to Babari, Black Aardi, Damascus, Kano brown and Nigerian Sahel goats [15]. Also, the WBCs in the Kiko goats were higher than the reference range as reported by [30].

RETIC values for all four seasons remained within the reference value range of 0.0-15.0 K/μL. The only fluctuation occurred during the spring with 0.01± 0.03 and a minimum value of 0.00 K/μL and with a maximum value of 0.1 K/μL. Neutrophiles percentage (NEU) was higher during the spring (53.8 ± 15.2) compared to summer (39.7 ± 11.1), fall (44.5 ± 5.1), and winter (42.5 ± 7.9). Basophil K/μL (BASO) had no seasonal fluctuations aside from exceeding the reference value (0.00-2.24 K/μ) L during spring (0.32 K/μL). Number of platelets (PLT) K/μL, has a reference value of 246-914 K/μL, no seasonal increases above this reference range were recorded. While the mean platelet volume (MPV) has no particular reference value for goats, values obtained in this study were significantly influenced by seasons (7.81 ± 0.35, 7.80 ± 0.33, 7.92 ± 0.43. and 8.22 ± 0.35 fL; $P \leq 0.05$). The percentage of monocytes, eosinophils and basophils in this study agreed with the data reported on the Barbari and black Aardi breed of goats [10] but slightly lower than the reported value in Damascus breed of goats [37]. However, these values were within the normal range reported by [30].

In this present study hematological and serum biochemical parameters were compared to standard, laboratory-dependent reference values. These reference values generally represent a 95% confidence interval. This means that 95% of normal animals should have a given blood profiles within this range. This also suggests that 5% of the population will be outside of this reference range and still be normal, emphasizing the need to clinically evaluate the animal. A number of factors, most notably physiologic state and age have been shown to influence blood hematological and serum biochemical parameters. Most reference ranges do not account for these differences and thus may confound direct interpretation. A new approach to hematological and serum biochemical profiling, which involves pooling larger sample numbers, specific animal selection relative to physiologic state and stage of production, must be examined in an effort to better interpret blood metabolite concentrations on a herd basis. Most importantly it must be remembered that metabolic profiles are almost useless without being coupled with environment and facility evaluations, body condition scoring and diet evaluation. It is only when the whole picture is evaluated will the uses of hematological and serum biochemical profiles produce useful diagnostic information.

Conclusion and Recommendations

The results of the present study suggest and show that seasonal variations do have a role on hematological and serum biochemical profiles in Kiko meat goats. The higher red blood cell values observed in this study may likely be a sign of healthier goats. The components of some of the hematological and serum biochemical parameters in Kiko goats in this study seem to point out some differences from those obtained for other meat goat breeds. Furthermore, the observed differences further support the fact that the physiological parameters reported for other meat goat breeds may not be applied on Kiko goats kept in this ecological zone (southeast Alabama). It is concluded that hematological and serum biochemical parameters were mostly within the physiological range for goats as reported from other studies. This data can contribute to our knowledge for monitoring health status, diagnosis of disease and management in this breed in Alabama. Moreover, this study underscores the need to establish appropriate physiological baseline values for meat breed goats in Alabama which could help in realistic valuation of the management practice, nutrition, diagnosis of health as well as in determining the physiological status of goats among limited resource producers who often prefer the Kiko breed of meat goat.

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