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Haematological and Serum Bio-Chemical Parameters of West African Dwarf and Kalahari Red Goats in the Humid Tropics

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Target audience: Animal Physiologist, Animal productionist, Researchers, Farmers;

Abstract

The comparative haematological and serum biochemical parameters of apparently healthy 7 West African Dwarf (WAD) bucks indigenous to the humid climate of West Africa and 7 Kalahari Red (KR) bucks introduced to the humid zone of Southwestern Nigeria from the semi arid sub tropical zone of South Africa was investigated to determine the health status and the adaptability of the KR to the humid zone. The animals were zero grazed and fed concentrate at 4 % dry matter body weight basis and Bracharia decumbens hay ad libitum for six months consisting of two seasons; cold dry season (November – January) and hot dry season (February – April).Blood samples were collected once a month via the jugular vein for haematological and serum bio chemical analysis. Data were analyzed for the effects of breed and season using a general linear model appropriate for 2 x 2 factorial format. Haematological results showed that white blood cell count, haemoglobin concentration, haematocrit, mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration were significantly ($p<0.001$) higher in the WAD than in KR goats (19.85×10^3 vs. 15.06×10^3; 91.71 g/dl vs.83.42 g/dl; 25.05 % vs. 22.14 %; 15.03 fl vs.13.86 fl; 5.4 pg vs. 5.14 pg; 381.90 g/dl vs. 368.65 g/dl respectively).Serum biochemical analysis showed that triglyceride was higher ($p<0.05$) in the WAD than the KR goats (98.3 mg/dl vs. 84.75 mg/dl).It can be concluded that WAD adapt better to the humid tropical conditions than the KR goats because of its rapid and potent defence against infectious agent as reflected in the white blood cell counts. However, the blood analysis of the KR indicated that it is a

breed that could thrive well in the humid tropics since the animals were apparently physically healthy.

Key words: biochemical; haematology; Kalahari red goats; West African dwarf goats

Description of problem

Globally, but especially in developing countries, goats play a vital role in the economy of many poor livestock owners who earn their livelihood by rearing these animals throughout the year on different terrains. With a goat population of 57.3 million, Nigeria contributes significantly to the goat population in Africa (321.5 million) (1).

Haematology refers to the study of the numbers and morphology of the cellular elements of the blood – the red cells (erythrocytes), white cells (leucocytes), and the platelets (thrombocytes) and the use of these results in the diagnosis and monitoring of disease (2). Haematological studies are useful in the diagnosis of many diseases as well as investigation of the extent of damage to blood (3). Blood is an important and reliable medium for assessing the health status of individual animal. Examining blood for their constituents is used to monitor and evaluate health and nutritional status of animals (4).

Blood act as a pathological reflector of the status of exposed animals to toxicant and other conditions (5). As reported by. (6) animals with good blood composition are likely to show good performance. The difference in the haematological and biochemical parameters as observed between breeds of goats, have further underlined the need to establish appropriate physiological baseline values for various breeds of livestock in Nigeria, which could help in the realistic evaluation of the management practice, nutrition and diagnosis of their health condition (7). Haematological studies are of ecological and physiological interest in helping to understand the relationship of blood characteristics to the environment (8) and so could be useful in the selection of animals that are genetically resistant to certain diseases and environmental conditions (6). The performance of animals is a product of interaction between the environment and genotype. Since genetic potentials cannot be expressed unless an adequate environment is provided, the maintenance of productivity is essentially a function of environment. The West African Dwarf goats are found in the region south of latitude 14^{o}N across West Africa in the coastal area, which is humid and favours high prevalence of diseases. The eco-zone is infested with tse-tse fly and the dwarf goats thrive well and reproduce with twins and triplet births in the ecological niche (9), thereby satisfying a part of the meat requirement in this region.

It is obvious that a lot of work had been done and reported on the haematology and serum biochemical parameters of indigenous goat breeds in Nigeria (7; 10; 11);however, there is paucity of information on the comparative haematology and serum biochemical parameters of an indigenous goat with

an exotic breed specifically the Kalahari Red goat in South-Western Nigeria to ascertain it's health and survivability status. The study was therefore designed to compare the haematological and serum biochemical parameters of the West African Dwarf already adapted to the humid zone with the Kalahari Red goat following its introduction to the humid zone so as to ascertain its health and survivability.

Materials and Methods

The study was conducted at the small ruminant unit of the Directorate of University Farms, Federal University of Agriculture Abeokuta, Ogun State, Nigeria for six months (November, 2011-April, 2012)consisting of two seasons; cold-dry season (November – January) and hot-dry season (February – April).The site lies within the derived savannah agro-ecological zone of southwestern Nigeria (latitude 7°N, longitude 3.5°E, and average annual rainfall 1,037 mm). Abeokuta has a bimodal rainfall pattern that typically peaks in July and September with a break of 2 to 3 weeks in August. Temperatures are fairly uniform with daytime values of 28–30 °C during the early rainy season of the year (April–June) and late rainy season (July–September) and 30–34 °C during the early dry season (October–December) and late dry season (January–March) with the lowest night temperature of around 24 °C during the harmattan period between December and February. Relative humidity is high during the rainy season with values between 63 % and 96 % as compared to the dry season (55–84 %). The temperature of the soil ranges from 24.5 to 31.0 °C [source: (12)].

Animals and management

Fourteen (14) male animals consisting of 7 Kalahari red and 7 West African Dwarf goats aged between 2-4 years with live weight ranging between(15-20 kg for West African Dwarf) and(60-68 kg for Kalahari red)were used.The 7 Kalahari Red bucks were imported from Elpasso farms, located in Sterkfontein, South Africa on the 10th of September, 2011 by the management of the Federal University of Agriculture, Abeokuta essentially for teaching and research. They were quarantined for two months (between 10th of September and 10th November, 2011) by the Nigeria Veterinary Quarantine Services, Ikeja following which a clean bill of health was then issued. On the other hand the West African Dwarf goats used for this study were sourced from local markets in Abeokuta, quarantined for one month and aged via dentition before the commencement of the experiment. They were raised intensively in a well ventilated pen with concrete floor and were fed *Bracharia decumbens* hay *ad libitum* and supplemented with concentrate (Table 1) fed at 4 % body weight dry matter basis daily. Water was supplied *ad libitum*.

Blood collection

Five (5) ml blood samples were collected from each goat via jugular vein puncture using a vacutainer needle. Blood samples were collected into a vacutainer tube containing ethylene diamine-tetraacetate (EDTA) as anti-coagulant for haematological studies. Haematological parameters were

determined by the aid of an auto–haemo analyser. On the other hand, 5 ml of blood was drawn into an anti-coagulant free tube and allowed to coagulate for about 6hrs. Blood samples were then centrifuged and serum obtained and stored in the refrigerator at -20° C for bio-chemical analysis. The haematological parameters determined include: haemoglobin concentration (Hb); red blood cell (RBC) count, mean corpuscular haemoglobin concentration (MCHC), mean corpuscular volume (MCV); mean corpuscular haemoglobin (MCH), white blood cell (WBC) count and haematocrit. The serum biochemical parameters determined include: Serum minerals: Calcium (Ca, mmol/l) according to (13), Phosphorus (P, mmol/l) according to (14), Sodium (Na, mmol/l), and Potassium (K, mmol/l) were according to (15). Serum protein: Total protein (TP, g/dl) using biuret method (16), Albumin (ALB, g/dl), and Globulin (GLOB, g/dl) were determined using bromocresol purple method of (17). Serum lipid: Triglyceride (mg/dl), Cholesterol (mg/dl). Serum sugar: Glucose (mg/dl) using glucose oxidase method described by (18).

Table 1: Gross composition of the concentrate feed (%)

Nutrients	Composition
Brewers dry grain	30
Wheat offal	40
Palm kernel cake	18
Maize	10
Common salt	1
Bone meal	1
	100 %

Statistical analysis

Data obtained were analyzed by method of least squares analysis of variance (19). The experimental design for this experiment was a general linear model appropriate for a (2x2) factorial format with the breed and season as independent variables and the haematological and serum biochemical parameters as the dependent variables.

Results

The results of the analysis of variance for the effects of season, breed and season by breed interaction on haematological parameters are summarized in Table 2. It was revealed from the table that season had a significant effect ($P< 0.05$) on the Red blood cell (RBC) count alone while there was no significant effect ($P>0.05$) on white blood cell (WBC) count, haemoglobin (Hb) concentration, haematocrit (HCT), mean corpuscular volume (MCV), Mean Corpuscular haemoglobin (MCH) and Mean Corpuscular haemoglobin concentration (MCHC). Breed had a highly significant effect ($P < 0.001$) on all the haematological parameters determine except RBC. The season by breed interaction on the other hand, was significant ($P < 0.05$) for haemoglobin concentration (HGB) only.

The least square means of red blood cell count as affected by season on Table 3 showed that the Red blood cell (RBC) count was higher in the cold-dry season than the hot-dry season by 5.9 %. Also, the Least squares means of haematological parameters as affected by breed on Table 4 showed that the white blood cell (WBC) count (19.85 vs.

Table 2: Summary of the analysis of variance of effects of season, breed and season by breed interaction on haematological parameters

Source of Variation	Df	WBC(10^3)	RBC (X10)	Hb (g/dl)	HCT (%)	MCV(fl)	MCH (Pg)	MCHC(g/dl)
Season	1	27.01^{ns}	17.76*	272.58^{ns}	7.75^{ns}	0.29^{ns}	0.05^{ns}	6.25^{ns}
Breed	1	463.66***	5.91^{ns}	1389.65***	170.59***	27.95***	1.48***	3550.90*
Season x Breed	1	2.60^{ns}	7.18^{ns}	653.65*	30.67^{ns}	0.09^{ns}	0.24^{ns}	222.37^{ns}
Error	77	15.29	3.29	123.66	10.56	1.49	0.07	746.73

ns-non-significant (P>0.05), *P<0.05, **P<0.01, ***P<0.001

15.06 **X10^3/µl)**, haemoglobin concentration (Hb) (91.71 vs. 83.42 g/dl), haematocrit (HCT) (25.05 vs. 22.14 %), mean corpuscular volume (MCV) (15.03 vs. 13.86 fl), mean corpuscular haemoglobin (MCH) (5.41 vs. 5.14 Pg) and mean corpuscular haemoglobin concentration (MCHC) (381.90 vs. 368.65 g/dl) were all higher in the West African Dwarf goats than the Kalahari Red goats. The percentage differentials in mean between the two breeds are: 31.8%, 9.9%, 13.1%, 8.4%, 5.3% and 3.6% in that order respectively.

Table 3: Least square means of Red blood cell count as affected by season

Source of variation	RBC (X10^6 / µl)
Cold dry season	16.68 ± 0.28^{a}
Hot dry season	15.74 ± 0.28^{b}

$^{a-b}$Means in the same column having different superscripts differ significantly (P < 0.05)

Table 4: Least square means of haematological parameters as affected breed

Breed	^{3}/µl)	RBC(X10^6/µl)	Hb (g/dl)	HCT (%)	MCV (fl)	MCH (Pg)	MCHC (g/dl)
WAD	19.85 ± 0.61^{a}	16.48 ± 0.28^{a}	91.71 ± 1.74^{a}	25.05 ± 0.51^{a}	15.03 ± 0.19^{a}	5.41 ± 0.04^{a}	381.90 ± 4.33^{a}
Kalahari Red	15.06 ± 0.62^{b}	15.94 ± 0.28^{a}	83.42 ± 1.76^{b}	22.14 ± 0.52^{b}	13.86 ± 0.19^{b}	5.14 ± 0.04^{b}	368.65 ± 4.27^{a}

$^{a-b}$ Means in the same column having different superscripts differ significantly (P < 0.05)
n=80
±SEM

Furthermore, the least square means of the interaction between season and breed on haemoglobin concentration on Table 5 revealed that haemoglobin concentration was generally higher in the West African Dwarf than the Kalahari Red goats. However, haemoglobin concentration was stable in the West African Dwarf in both seasons but was higher in the cold-dry than the hot-dry season in the Kalahari Red by 11.9%.

The results of the analysis of variance for the effects of season, breed and season by breed interaction on biochemical parameters are summarized in Table 6. The results showed that breed and season had a significant effect (P< 0.05) on serum triglyceride concentration alone while the season by breed interaction was not significant (P > 0.05) for any of the bio-chemical parameters determined in this experiment.

Table 5: Least square means of haemoglobin concentration showing the interaction between season and breed

Season	Hb (g/dl)	
	WAD	Kalahari Red
Cold dry	90.70 ± 2.45^{c}	88.10 ± 2.43^{a}
Hot dry	92.71 ± 2.43^{a,c}	78.74 ± 2.55^{b}

$^{a - c}$ Means having different superscripts differ significantly (P < 0.05)
n=80
±SEM

Table 6: Summary of the analysis of variance of the effects of season, breed and season by breed on serum biochemical parameters

Source of variation	df	TP	ALB	GLOB	GLUC	TRIG	CHOL	Ca	K	Na
Season	1	0.22^{ns}	0.11^{ns}	0.10^{ns}	22.02^{ns}	3669.23*	1.67^{ns}	0.16^{ns}	35.12^{ns}	231.47^{ns}
Breed	1	1.89^{ns}	0.55^{ns}	0.11^{ns}	0.52^{ns}	3601.66*	319.88^{ns}	2.92^{ns}	26.77^{ns}	34.41^{ns}
Season x Breed	1	0.04^{ns}	0.12^{ns}	0.01^{ns}	61.96^{ns}	1383.68^{ns}	53.27^{ns}	0.14^{ns}	26.38^{ns}	0.56^{ns}
Error	75	1.17	0.43	0.38	55.95	712.01	106.73	0.93	36.18	99.76

ns-Non-significant (P.0.05), *P<0.05 TP - Total protein; ALB -Albumin, GLOB - Globulin; GLUC -Glucose; TRIG - Triglyceride;CHOL - Cholesterol; Ca - Calcium; K - Potassium; Na - Sodium

Serum triglyceride concentration was higher in the cold-dry than the hot-dry season (98.33 vs. 84.82 md/dl) by 15.9% as shown in the least square means of serum triglyceride concentration as affected by season on Table 7.

Table 7: Least square means of serum triglyceride concentration as affected by season

Season	Triglyceride (mg/dl)
Cold-dry season	98.33 ± 4.22^{a}
Hot-dry season	84.82 ± 4.17^{b}

$^{a-b}$ Means in the same column having different superscripts differ significantly (P < 0.05)
n=79
±SEM

Table 8: Least square means of serum Triglyceride concentration as affected by breed

Breed	Triglyceride (mg/dl)
WAD	98.3 ± 4.17^{a}
Kalahari Red	84.75 ± 4.22^{b}

^{a} - ^{b}Means in the same column having different superscripts differ significantly (P < 0.05)
n=79
±SEM

Table 9: Reference mean values for haematological and serum bio -chemical parameters in goats

Parameters	Range	Present study WAD goats	Present study KR goats
WBC	6.8 - 20.1	19.85±0.61	15.06±0.62
Hb	7.0-15.0	91.71±1.74	83.42±1.76
MCV (fl)	50.0 - 68	15.03±0.19	13.86±0.19
MCH (Pg)	8.0 - 12.0	5.41±0.64	5.14±0.04
MCHC	31.0 - 38.0	381.90±4.33	368.65±4.27
Triglyceride	0.16 - 1.6	98.3±4.17	84.75±4.22
Calcium	1.15 - 2.4	4.50±0.16	4.45±0.15
Sodium	124 - 146	128.47±1.87	125.0±1.87
Potassium	3.0 - 6.0	4.77±0.88	3.44±0.87
Albumin	2.8 - 4.3	3.37±3.29	3.29±1.82
Total Protein	6.3 - 8.5	5.19±0.17	5.09±0.17

Adapted from: (11)

Discussion

The white blood cell (WBC) count in this study was higher in the WAD goats than the Kalahari Red (19.85 vs. 15.06 x $10^{3}/\mu l$) which indicates that the WAD goats seem to possess a protective system, providing a rapid and potent defense against infectious agents and

this is probably the physiological basis for the adaptation of this species to this ecological zone (humid tropics) characterized by high prevalence of disease. On the other hand, the WBC count in the Kalahari Red goat throughout the experimental period was also high which showed that they also possess a high protective mechanism against infectious diseases hence, their ability to survive in the humid tropics. The WBC count in the WAD and Kalahari Red goats in this study (19.85 x 10^3/µl and 15.06 x 10^3/µl) was higher than the report of (10) in Red Sokoto goats and (11) in WAD goats who recorded mean values of 10.6 x 10^3/µl and 13.5 x 10^3/ µl respectively. Thewhite blood cell (WBC) count values in both breeds in this experiment fell within the normal mean value of 6.8 - 20.1 x 10^3/ µl for goats as stated by (11). The haemoglobin concentration (Hb) in the WAD goats in this study was higher than that of the Kalahari Red (91.71 g/dl vs. 83.42 g/dl). Though, haemoglobin concentration in both breeds was higher than that obtained by (10) in the Red Sokoto goats, the WAD goats have a higher haemoglobin concentration. Hence WAD goat seems to possess relatively high haemoglobin values which is an advantage in terms of the oxygen carrying capacity of the blood. The significant breed difference recorded in MCV, MCH and MCHC by the WAD goats in this study, might suggest a physiological activeness of the male WAD goat which is in line with the findings of (20), who reported physiological activeness among sheep and goat breeds of different age groups and sex. The higher MCV and MCH value of 15.03(fl) and 5.41 (pg) recorded in the adult male WAD goat as against the value of 13.86 (fl) and 5.14 (pg) in the adult Kalahari Red male in this study was lower than the values obtained by (21) who recorded mean values of 17.59 (fl) and 5.64 (pg) respectively while monitoring the influence of management and sex on haematology of the West African Dwarf goats. The high MCHC value of 381.90 g/dl in WAD vs. 368.65 g/dl in the Kalahari Red goats in this study fell below the value of 333.2 g/dl obtained for adult male WAD goats(7). The significant higher value of the RBC in the cold-dry season in this study could be as a result of the high plane of nutrition that is*ad libitum* feeding of *Bracharia decumbens* hay and high crude protein content of the supplementary feed (17.2%). The high serum triglyceride concentration in the WAD goats (98.3 mg/dl) as against the value of (84.75 mg/dl) in the Kalahari Red goats in the cold dry season could suggest a high utilization of energy in the cold dry season. The non-significant ($P>0.05$) effect of breed on serum calcium and potassium in this study agrees with the findings of (11). However, the mean values of (4.54 ± 0.15 mmol/l and 4.77 ± 0.87 mmol/l vs. 4.45± 0.15 mmol/l and 3.44 ± 0.87 mmol/l) for calcium and potassium in the WAD and Kalahari Red goats respectively in this experiment were higher than(1.6 ± 0.5 mmol/l and 1.3 ± 0.8mmol/l)the values obtained by (11). The high serum calcium and potassium levels were probably a result of the high feeding regime the animals were

subjected to as stated by (11), who obtained low values of serum calcium and potassium in his study as a consequence of the low feeding regimen. Though breed had no significant effect (P>0.05) on sodium level in this study, the low level of sodium in this study in the two breeds(128.47 ± 1.87 vs. 125 ± 1.87 mmol/litre) is outstanding compared with other breeds kept in Nigeria such as Red Sokoto, with; 138.0 ± 0.6mmol/litre (10); WAD, 135.1 ± 1.7 mmol/litre (11). This suggests that the WAD and Kalahari Red goats were similar to man which have shown to have lower sodium levels in tropical environment which suggest the ability to regulate osmotic pressure and maintain metabolic potential. This close association between tropical environment and lower sodium levels in man has been attributed to the variable dietary intake of salt and loss of sodium and chlorine ions in urine under tropical environmental conditions.

Conclusions and Applications

It is concluded from this study that;

1. The WAD goats is physiologically well adapted to the humid tropics than the Kalahari Red goats.

2. The Kalahari Red goats could however also thrive well in the humid tropics since the haematological and serum biochemical parameters obtained in this study compared well with that of WAD goats.

3. Physical examination throughout the study period also indicated that the animals were healthy.

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