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Effect of breeds on haematological parameters and some serum biochemical profiles of goat exposed to heat stress

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ABSTRACT

This study examined the effect of breed on serum biochemical profiles and haematological markers in heat-stressed West African dwarf and Red Sokoto goats. The Temperature Humidity Index (THI) was computed using the recorded ambient temperature and relative humidity of the research. 95 goats in the Nigerian states of Osun, Oyo, and Kwara—50 Red Sokoto and 45 West African Dwarf goat breeds—had blood collected from them, all of whom appeared to be in good health. Haematological parameters (Packed Cell Volume (PCV%), haemoglobin (Hbxg/dl), red blood cell counts (RBC x10^6/µl), white blood cell counts (WBC x 10^3/µl) and serum biochemistry, which includes total protein (TP x g/dl), albumin (ALxg/dl), globulin (GL x g/dl), albumin and globulin ratio (AL/GL%), glucose (GLU x Mg/dl), sodium(Na^+x mmol/L), potassium (K^+x mmol/L) and calcium (Ca^{2+}x mmol/L) concentrations in RS and WAD goat breeds were carried out. The results of the investigation showed variations in haematological and biochemical parameters between breeds.

Keywords: haematological, heat stress, Red Sokoto goats, serum biochemical parameters, West African Dwarf

1. Introduction

The biggest element affecting animal output in a changing climate is heat stress. Therefore, research is needed to find breeds that are thermotolerant so that livestock output can be optimised even in the face of heat stress [1]. Many low-income livestock owners depend heavily on the income from raising goats, which they do year-round on a variety of terrains worldwide, but particularly in developing nations. With 57.3 million goats, Nigeria makes up a substantial portion of Africa's total goat population of 321.5 million [1]. These animals also perform better than other domesticated ruminants [2] and are highly suited to a range of environmental circumstances, including hard and extreme temperatures [3], [4].

In Nigeria, the rural economy is greatly influenced by the production of goats. In West *Africa*, particularly Nigeria, goats are traditionally raised for food. Usually, they are left on their own to fend for themselves and scavenge [23]. The goat's diet may include leftovers from the home, the exact makeup of which is determined by the family's menu. The entirety of the goat's feeding schedule characterises the traditional methods of goat

husbandry. Sheep are less able to withstand heat than goats [5], [6]. High levels of both direct and indirect solar radiation are considered environmental stresses due to climate change [7]. Being a temperature-sensitive system, the blood system is a crucial gauge of the body's reactions to stressors [15].

The purpose of this study is to determine the serum biochemical and haematological reactions of Red Sokoto and West African dwarf goats to heat stress in their natural pasture. The study of blood's biological components, including red blood cells (erythrocytes), white blood cells (leucocytes), and platelets (thrombocytes), as well as their application in illness diagnosis and surveillance, is known as haematology [2]. Numerous disorders can be diagnosed and the degree of blood damage can be investigated with the use of haematological research [3]. Blood is a crucial and reliable tool for assessing the health of a certain animal. Animal health and nutritional status are tracked and assessed using blood constituent analysis [4].

Blood is a pathological reflector of an animal's health status after exposure to toxins and other factors [5]. Animals with a healthy blood composition have a higher chance of performing well, per [6]. The need to establish appropriate physiological baseline values for different breeds of livestock in Nigeria has been brought to light by the differences in haematological and biochemical parameters observed between breeds of goats. This could help with the realistic evaluation of management practices, nutrition, and health condition diagnosis [7]. Because they help understand how blood characteristics relate to the environment [8], haematological studies are of ecological and physiological interest. This understanding may be useful in the selection of animals that are genetically resistant to specific diseases and environmental conditions [6]. Environment and genotype interact to determine animal performance. Productivity maintenance is fundamentally a function of the environment since genetic potentials cannot be developed in the absence of an adequate environment.

West African Dwarf goats are found in West Africa south of latitude 14ºN, along the coast, where it is humid and disease prevalence is common. Because of the tse-tse fly infestation in the ecozone, dwarf goats are able to breed in the biological niche and meet part of the region's meat requirement by giving birth to twins and triplets [9]. Native to the northwest Nigerian region of Sokoto are red Sokoto goats. They migrated to Niger, Mali, and Burkina Faso, among other places in West Africa, over time. These places are typically semi-arid, which is a favourable climate for the breed. Being able to withstand extreme weather is one of the noteworthy qualities of Red Sokoto goats. They have a high level of resistance to numerous diseases that are prevalent in tropical regions and can survive on very little food. They are the perfect breed for smallholder and pastoral farming systems in semi-arid areas because of their resilience. Undoubtedly, a great deal of research has been conducted and documented regarding the haematology and serum biochemical parameters of native goat breeds in Nigeria (7, 10, 11); on the other hand, little is known about how these parameters compare among native goat breeds in Nigeria when it comes to heat stress (specifically, WAD and RS goats) and survivability. In order to assess the health and survivability of West African dwarf goats and Red Sokoto goats under heat stress in a humid zone, a comparison of their serum biochemical and haematological parameters was included in the study design.

2. Materials and Methods

2.1. Experimental Animals and Site

A total of 95 experimental animals were utilized in this study, which included 45 West African Dwarf (23 male and 22 female) and 50 Red Sokoto goats (25 male and 25 female), which are primarily found in Nigeria's South West. Data and samples from the animals were collected from various farms in Osun, Oyo, and Kwara States, Nigeria from August 2018 – February 2019. The agro-ecosystems of Osun, Oyo, and Kwara States in Nigeria are characterized by diverse climates and agricultural practices. Osun State, located in southwestern Nigeria, experiences a tropical rainforest climate. The annual mean rainfall is approximately 1,200 mm to 1,400 mm. The region has two distinct wet seasons: the main rainy season occurs from April to July, while a shorter, less intense rainy period occurs from September to November. The annual mean temperature in Osun State ranges between 24°C and 28°C. The hottest months are typically February and March, while the cooler months are December and January. Temperatures tend to be relatively stable due to the tropical climate, with slight variations influenced by the rainy and dry seasons. Osun State is predominantly covered by tropical rainforest vegetation, characterized by dense forests with a rich diversity of plant species.

Oyo State, located in southwestern Nigeria, has a tropical savanna climate with distinct wet and dry seasons. In Oyo State, there is an annual mean rainfall of between 1,200 and 1,500 mm. The rainy season typically spans from April to October, with a peak in rainfall occurring between June and September. The annual mean

temperature in Oyo State is between 25°C and 29°C. The vegetation in Oyo State is characterized by a mix of tropical rainforest and guinea savanna.

Kwara State, situated in the north-central region of Nigeria, experiences a tropical wet and dry climate. In Kwara State, there is an approximate range of 1,000 to 1,500 mm of annual mean rainfall. The rainy season normally lasts from April through October, with June through September seeing the most of the precipitation. The annual mean temperature in Kwara State is between 25°C and 30°C. The vegetation in Kwara State is primarily characterized by guinea savanna, also known as tropical savanna. These states collectively enhance Nigeria's agricultural productivity, utilizing both rain-fed and irrigation farming systems to maximize yield and support local economies. The laboratory analysis was carried out at the Federal University of Technology's Bio-safety Research Laboratory in Akure, Ondo State.

2.2. Experimental Animals and Their Management

This research work focused on goats of the West African Dwarf (WAD) and Red Sokoto breeds, which appeared to be in good health. In the agricultural ecological zone, these breeds are typically stock raising under extensive or semi-intensive husbandry, with the animals being fed cassava peels, corn shafts, kitchen trash, agricultural leftovers, and, most commonly, garbage piles. The residents in these towns have adopted this style of goat rearing in order to lessen food conflict between humans and goats. The animals' records were not kept properly. Ethno-veterinary medicine was a prevalent practice at the time.

2.3. Analysis of Environmental Conditions Prevailing During Study

At the time of collection, the ambient temperature (°C) and relative humidity (RH) (percent) were measured with a digital thermometer and hygrometer and recorded, respectively. This research employed an equation to calculate the index of temperature humidity (THI).

$$THI = 0.8*T + RH * (T – 14.4) + 46.4 \quad (1)$$

where: T = ambient temperature (°C); RH = relative temperature (%)

2.4. Haematological analysis

Each goat's jugular vein was tapped for blood. Two 5 ml vacuum tubes were used to hold the blood samples. For haematological evaluation, ethylene diamine tetra-acetic acid is included in one of the five millilitre blood tubes (anti-coagulant). Packet cell volume (PCV, percent), hemoglobin (Hb, g/dl), red blood cell (RBC X 10^6/L), and white blood cell (WBC X10^4/L) were assessed by [31], [26].

2.5. Serum biochemical analysis

Serum was extracted from the second 5 ml vacuum set of blood tubes, spun at 3500 rpm for 20 minutes, and stored at -20°C for chemical analysis. Using the [9] technique, the levels of albumin (Al, g/dl) and total plasma proteins (TP, g/dl) were determined. The concentration of total serum globulins (Gl, g/dl) was calculated using the difference between total serum proteins and serum albumin. This method was used by [10] and [3] to determine the following: glucose (Glu, mg/dl), sodium (Na+, mmol/L), potassium (K+, mmol/L), and calcium (Ca2+, mmol/L).

2.6. Data analysis

The SAS (2003) program was used to analyze the data. The linear model is employed, which is as follows:

$$Y_{ij} = \mu + {}_{+}A_i + E_{ij} \quad (2)$$

where: Y_{ij} = single observation; μ = overall mean (constant); A_i = fixed effect of breed (WAD and RS goat breed); E_{ij} = Random residual error. Duncan's multiple range test was used to separate the means.

3. Result

3.1. Environmental conditions prevailing during the study

Table 1 shows the environmental conditions that prevailed during the experimental period. The ambient temperature ranged from 25 – 36°C with an average of 31.44±0.10°C. The relative humidity ranged from 76.16-89.5% with an average of 83.93±0.11%. The temperature humidity index (THI) during the test period ranged from 74.44-94.54 with an average of 86.26±0.32.

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Table 1. Environmental conditions prevailing during the study

Parameters	Range	Mean±SEM
Environmental conditions		
Ambient Temperature (°C)	25 – 36 om	31.44±0.10
Relative humidity (%)	76.16 – 89.5	83.93±0.11
Temperature Humidity Index (THI)	74.44 – 94.54	86.26±0.32

Note: SEM = Standard error of mean

3.2. Effect of Breed on Haematological and Biochemical Indices of Wad and Red Sokoto Goats

Tables 2 and 3 show the mean values of haematological (PCV, HB, RBC, WBC) and biochemical (TP, ALB, GLOBU, GLUCOSE, Na^+, K^+, Ca^{2+}) indices in WAD and RS goats. The results showed that there were significant differences ($p<0.05$) for the mean values of all blood parameters except albumin and globulin ratio, that showed no significant difference ($p>0.05$) in WAD and RS goats (2.30 – 2.22).

Table 2. Effect of breed on haematological parameters of wad and Rs goats

Source of variation	PCV	HB	RBC	WBC
WAD	29.97 ^{a}	8.82 ^{a}	10.55 ^{a}	10.17 ^{a}
RS	27.35 ^{b}	6.90 ^{b}	8.02 ^{b}	6.32 ^{b}

Note: Means with different superscripts on the same column are significantly different ($P<0.05$); WAD = West Africa Dwarf Goat; RS = Red Sokoto Goat; PCV = Packed cell volume; HB = Haemoglobin; RBC = Red Blood Cell; WBC = White Blood Cell

Table 3. Effect of breed on serum biochemical indices of wad and red Sokoto goats

Source of variation	TP	ALB	GLOB	AGR	GLU	Na^+	K^+	Ca^{2+}
WAD	4.72 ^{a}	3.24 ^{a}	1.43 ^{a}	2.30 ^{a}	68.74 ^{a}	95.36 ^{a}	4.94 ^{a}	11.15 ^{a}
RS	3.57 ^{b}	2.44 ^{b}	1.08 ^{b}	2.22 ^{a}	56.81 ^{b}	78.81 ^{b}	3.76 ^{b}	10.11 ^{b}

Note: Means with different superscripts on the same column are significantly different ($P<0.05$); TP = Total Protein; ALB = Albumin; GLOB = Globulin; AGR = Albumin to Globulin Ratio; Na^+ = Sodium ion; K^+ = Potassium ion; Ca^{2+} = Calcium ion

Table 4. Distribution of haematological and biochemical indices of wad and Rs goats

Source of Variation	TP	ALB	GLOB	AGR	GLU	Na^+	K^+	Ca^{2+}	PCV	HB	RBC	WBC
WAD	4.72^a	3.24^a	1.43^a	2.30^a	68.74^a	95.36^a	4.94^a	11.15^a	29.97^a	8.82^a	10.55^a	10.17^a
RS	3.57^b	2.44^b	1.08^b	2.22^b	56.81^b	78.81^b	3.76^b	10.11^b	27.35^b	6.90^b	8.02^b	6.32^b

A substantial statistical difference ($p<0.05$) was observed in the mean values of haematological parameters according to breeds in the study. This is consistent with a [1] report. They discovered a marked drop in the levels of albumin, glucose, urea, creatinine, and total proteins in the serum of pregnant adult female Zarabia goats. According to [18], there were changes in antioxidant levels, plasma or serum enzymes, and metabolites such as blood glucose and total cholesterol levels. [1] discovered that after being subjected to heat stress in the Sinai desert, goats of the Balady and Damascus breeds had significantly greater plasma Na^+ concentrations. However, [26] found that dwarf goats subjected to heat stress had markedly elevated blood K^+ and decreased serum Ca^{2+}. Similarly, numerous heat-stressed Black Bengal goats had considerably greater blood parameters, including PCV, haemoglobin, WBC, and RBC levels [13 and 15]. In reaction to low oxygen levels, [29] suggests that a decrease in oxygen tension may cause a rise in erythropoietin synthesis, which in turn may contribute to an increase in red blood cell count and haemoglobin concentration during heat stress.

According to this study, the WAD goats had a higher white blood cell (WBC) count (10.55 vs. 8.02) than the RS goats, suggesting that the WAD goats have a defence mechanism that offers a quick and effective defence against infectious pathogens. This is probably the physiological underpinning of this species' adaptation to

this ecological zone (the wet tropics), which is marked by a high incidence of disease, according to [19]. However, the RS goat's WBC count remained high throughout the trial, indicating that they have a strong defence against infectious diseases, which accounts for their capacity to thrive in the humid tropical climate. The study's WBC count (10.55 vs. 8.02) in the WAD and RS goats was almost exactly the same as what was reported in [10] for Red Sokoto goats and [11] for WAD goats, with mean values of 10.6 x 10 /µl and 13.5 x 10 /µl, respectively. According to [11], the white blood cell (WBC) count results in both breeds in this investigation were within the usual mean value range of 6.8 - 20.1 x 10 /µl for goats. The haemoglobin concentrations (Hb) of the WAD goats in this study were greater than those of the RS goats (8.82 g/dl vs. 6.90 g/dl).

The WAD goats have a higher haemoglobin content, even though the concentration was greater in both breeds than that found in the Red Sokoto goats [10]. The WAD goat appears to have relatively high haemoglobin levels as a result, which is beneficial for the blood's ability to carry oxygen. The high level of nutrition in this study, which consists of feeding Brachariadecumbens hay ad libitum and periodically supplementing feed with a high crude protein content of 17.2%, maybe the cause of the much increased RBC value.

In this experiment, the average potassium and calcium values in the WAD and RS goats were 4.94 mmol/l and 11.15 mmol/l, respectively, compared to 3.76 mmol/l and 10.11 mmol/l. These values were greater than those found by (4.5 ± 0.3 mmol/l and 1.6 ± 0.5 mmol/l) (11). According to [11], who reported low serum calcium and potassium levels in his study as a result of the low feeding regimen, the high feeding regimen the animals received was most likely the reason for the high serum potassium and calcium levels. Comparing the salt levels in the two breeds, WAD and RS (95.36 vs. 78.81 mmol/litre) in this study to those of other researchers on RS (138.0 ± 0.6 mmol/litre (10); WAD (135.1 ± 1.7 mmol/litre) is remarkable [11]. This suggests that the WAD and RS goats were comparable to humans, who in tropical climates have lower salt levels, suggesting that they were able to control osmotic pressure and sustain metabolic capacity. Variable salt intake and the loss of sodium and chlorine ions in urine under tropical environmental circumstances have been linked to the strong association between decreased sodium levels in humans and tropical environments. Comparably, serum total protein in this study was greater (4.72 g/l in WAD) and lower (3.75 g/l in RS) than in Red Sokoto goats (4.4 ± 1.5 g/100 litres [24]) and WAD sheep (6.3 ± 0.7 g/100 litres [24]; [30]).

4. Conclusion

This study concluded that breed had a statistically significant ($p<0.05$) effect on haematological and serum biochemical parameters. WAD goats are more physiologically adapted to the humid ecological zone than Red Sokoto goats. The study's haematological and serum biochemical measures and those from WAD goats showed good agreement, indicating that Red Sokoto goats could adapt well in this location. Physical examination of the animals throughout the study period revealed that they were healthy.

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