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ORIGINAL RESEARCH ARTICLE

Effect of seasonal variation on haematology and serum biochemical parameters of West African Dwarf sheep reared semi-intensively

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ABSTRACT

This study investigated the effect of season on the haematological and biochemical parameters of 100 (50 male and 50 female) apparently healthy growing West African Dwarf (WAD) sheep with an average weight of 12.25kg reared semi intensively. Blood samples were collected fortnightly throughout the 9-months experimental period. Haematological and biochemical parameters in blood were measured and analyzed separately for both seasons. Means of parameters measured between the male and female sheep for both seasons were compared using one way analysis of variance. The results showed that all haematological and biochemical parameters measured did not differ significantly during the dry season. However, in the rainy season, mean corpuscular volume (MCV) and the mean corpuscular haemoglobin were significantly ($p<0.05$) different, with rams having a higher value than females. All parameters measured however, were within the normal range for WAD sheep. It can be concluded that within the seasons, sexual differences did not influence serum chemistry and the health status of WAD sheep.

Key words: Haematology, blood chemistry, WAD sheep, season

INTRODUCTION

Sheep (*Ovis aries*) are vital small ruminants in the tropics, significantly supporting rural livelihoods. The global population of sheep is approximately 1,130.8 million, with Africa accounting for 16.3% of this number (Ozung *et al.,* 2011). In Southern Nigeria's rainforest belt, sheep represent about 63.7% of the total grazing domestic animals (Yakubu *et al.,* 2011). Sheep and goats constitute one of the important meats and milk sources in the world. In the context of environmental changes, the improvement and conservation of these species is a must to meet the growing meat and dairy needs of people both nationally and internationally in a sustainable way. Semi-intensive system is reported to be the most common in greater parts of humid tropics and that it is touted to have high production potential with less labor input compared to the extensive and intensive systems (Ajala *et al.,* 2008). The rearing of sheep under a semi-intensive system of management also creates a balance between animal welfare and productivity of the animals. Nevertheless, there are problems relating to the anticipation of poor production owing to mineral deficiencies and other associated factors (heat stress, physical stress, and worm infestation) in grazing livestock (Maurya *et al.,* 2012; Kumar *et al.,* 2013). These factors can impair productive performance, affecting health and welfare of the animals.

Sheep management during the dry and rainy seasons presents distinct challenges to their health and productivity. The dry season's reduced forage quality and availability can lead to inadequate dietary intake, compromising milk production in lactating ewes and growth rates in lambs (Akinlade *et al.,* 2015). Conversely, the rainy season's increased humidity can impact overall well-being. In Nigeria, the dry season's feed scarcity has been identified as a major constraint to successful ruminant production, resulting in poor animal nourishment and decreased performance in growth, work, maintenance, production, and reproduction (Alade *et al.,* 2017; Olabode *et al.,* 2018). There is variation in seasonal availability of natural pasture as pasture tends to be more succulent, highly nutritious and more abundant in the rainy season (around March- September) as opposed to the dry season (around September - April) where they become fibrous, scarce and devoid of most essential nutrients such as protein, energy, vitamins and minerals which are required for increased rumen microbial fermentation that will results into production of volatile fatty acid and consequently performances of the host animal in the area of maintenance, production and reproduction (Sowande, 2004; Lamidi, 2000; Yusuf *et al.,*2017). Blood is an important index of physiological and pathological changes in an organism (Mitruka and Rawnshey, 1977). Blood parameters are a crucial indicator of physiological and pathological changes in animals (Kumar *et al.,* 2018). Haematological and biochemical tests are essential diagnostic tools for assessing the health status, nutritional adequacy, and

disease presence in animals (Alade *et al*., 2017). These tests provide valuable information that complements physical examination and medical history, enabling accurate medical judgment and diagnosis (Olabode *et al*., 2018). Furthermore, blood parameters help determine the extent of tissue and organ damage, evaluate the host's defense mechanisms, and aid in identifying potential anemia types (Lawal-Adebowale *et al*., 2019). Hence, this study investigated the effects of dry and rainy seasons on haematological and serum biochemical parameters in semi-intensively raised sheep.

MATERIALS AND METHOD

Experimental Site

The experiment was carried out at the Small Ruminant Experimental Unit of Directorate of University Farms (DUFARMS), Federal University of Agriculture Abeokuta, Nigeria. Abeokuta is located in the rainforest vegetation zone of South-Western Nigeria on latitude 7˚ 13' 49.46'' N, longitude 3˚ 26' 11.98''E and an altitude 76 m above sea level. It is located in the derived savannah zone of South-Western Nigeria. It has a humid climate with mean annual rainfall of about 1037 mm and temperature of about 34.7 °C. The relative humidity ranges in the rainy season (late March to October) and dry season (November to early March) are between 63 – 96% and 55 – 82%, respectively, with an annual average of 74%.

Experimental Animals and Management

One hundred West African Dwarf sheep were randomly selected for blood collection from a population (n=200) of a WAD sheep resident in the farm. The selection of animals was done to purposively comprise of 50 male and 50 female sheep. The animals were already stabilized as they have been on the university farm for a period of time. The blood samples were collected during the Dry (December 2023 and January 2024) and Rainy Season (May and June 2024) and were analyed using standard procedures. The average relative humidity, rainfall and temperature during the dry season are 73.05%, 0.00 mm, 27.25^0c respectively, while that documented during the rainy season are 81.28%, 162.1mm, 27.41^0C, respectively.

Table 1: Means of Agrometeorological Observations in 2024

Months	Max. Temp (°C)	Min. Temp (°C)	Mean Temp (°C)	Rainfall (mm)	Rel. Humidity (%)
Jan	34.8	22.1	28..45	0.00	70.70
Feb	33.97	21.59	27.78	42.0	73.38
Mar	35.37	23.58	29.48	43.8	77.0
Apr	35.5	22.4	28.95	74	75.4
May	33.26	22.27	27.76	160.9	81.61
Jun	31.8	22.3	27.05	163.3	80.95
Jul	28.44	21.87	25.15	35.1	85.08
Aug	27.5	21.7	24.6	50.4	81.7
Sept	30.3	22.7	26.5	95.3	82.4
Oct	32.93	23.7	28.32	20.78	83.7
Nov	32.5	24.6	28.55	9.7	83.9
Dec	32.3	22.8	27.55	0.00	144.42

Source: Department of Agrometeorological and Water Management, University of Agriculture, Abeokuta.

Table 2: Means of Agrometeorological Observation in 2023

Months	Max. Temp (°C)	Min. Temp (°C)	Mean Temp (°C)	Rainfall (mm)	Rel. Humidity (%)
Jan	34.6	20.9	27.75	10.72	55.4
Feb	33.4	20.8	27.1	12.6	73.4
Mar	33.5	21.2	27.35	37.4	77.23
Apr	31.8	21..2	26.5	116.5	79.7
May	32.8	21.7	27.25	102.3	76.2
Jun	31.8	21.9	26.85	217.3	85.9
Jul	27.5	21.1	24.3	148.9	81.9
Aug	30.3	20.8	25.55	56.4	81.8
Sept	31.4	20.9	26.15	131.2	81
Oct	32.7	21.4	27.05	236.2	80.8
Nov	32.3	21.9	27.1	38.4	79.3
Dec	31.3	20.8	26.06	0.00	75.4

Source: Department of Agrometeorological and Water Management, University of Agriculture, Abeokuta.

Experimental Diet
The animals were allowed to graze and offered on cassava peels at 0016h and they were also feed on formulated concentrate as supplement which contain Palm kernel cake (5%), maize (5%), rice bran (20%), wheat offal (25%), maize offal (25%), bone meal (3.5%) and salt (1.5%)

Data Collection
Blood samples were collected from the jugular vein of apparently 100 healthy sheep comprising of 50 male sheep and 50 female sheep during the dry and rainy season. The sheep were bled through jugular vein and 10ml of blood collected. Approximately 3ml of the blood samples was collected into plastic tube containing EDTA for haematological studies. The remaining 7ml of blood samples was deposited in anticoagulant free plastic tube and allowed to clot at room temperature within 3 hours of collection. The serum samples were stored at -20^{0}C for biochemical studies. Total erythrocytic counts and total leukocytic counts were determined with the aid of Haemocytometer (Neubaur counting chamber) and Hb concentration was determined by Sahl's (acid haematin) method (Benjamin, 1978). Mean Corpuscular Haemoglobin Concentration (MCHC), Mean Corpuscular Haemoglobin (MCH), Mean Corpuscular Volume (MCV) values were calculated (Jain, 1986). Serum Alanine Aminotransferase was analyzed using spectrophotometric-linked reaction method (Henry *et al.*, 1960). Other biochemical analysis (total protein, albumin and globulin) was done using the method described by (Ogunsami *et al.*, 2002).

Statistical analysis
Data collected was subjected to one-way analysis of variance SAS (version 27) to compare the variation between male and female sheep. Significance differences among means were separated using Tukey test of the same software package.

RESULTS
Table 3 shows the haematological parameters of sheep reared semi-intensively during the dry season, comparing the male and female, the parameters considered were not differed ($p > 0.05$). The results of biochemical indices of the experimental sheep during dry season are presented in Table 4. The serum biochemical parameters of WAD sheep reared semi-intensively during the dry season, comparing the male and female, the parameters considered were not differed ($p > 0.05$). Table 5 shows the haematological parameters of sheep reared semi-intensively during the rainy season. The Mean Corpuscular Volume and the Mean Corpuscular Haemoglobin levels were significantly ($p<0.05$) differed between the male and the female sheep with the male having the highest levels ($p > 0.05$). Table 6 represents the serum biochemical indices of both male and female sheep reared semi intensively during the raining season. No significant difference was observed for all serum biochemical parameters of the compared male and female WAD sheep reared semi-intensively during the rainy season. ($p>0.05$).

DISCUSSION
The hematological profiles of West African Dwarf sheep demonstrate significant seasonal and sex-related fluctuations, with important implications for their health, management, and welfare. A study by Fasae *et al*. (2017) and Fadare *et al*. (2012) revealed that packed cell volume (PCV) values for both male and female West African Dwarf sheep fell below the reference range (Okoruwa, 2015) during the dry season. Conversely, during the rainy season, PCV and hemoglobin (Hb) levels were within the reference ranges (Fadare, *et al*., 2012), indicating that anemia is less prevalent during this period.

Table 3: Haematological Parameters of sheep reared semi-intensively during the dry season.

Parameters	Female	Male	Reference range
Packed Cell Volume (%)	21.80 ± 4.15	25.75 ± 2.86	27 – 45*
Haemoglobin (g/dl)	7.20 ± 1.30	8.54 ± 1.12	9.0 – 15.0*
Red Blood Cell (x10^{12}/L)	9.80 ± 2.05	11.72 ± 1.48	9.0 – 15.0*
White Blood Cell (x10^9/ L)	6.40 ± 2.51	6.75 ± 1.48	4.0 – 8.0*
Neutrophils (%)	35.0 ± 2.23	35.98 ± 3.24	10 -50*
Lymphocyte (%)	62.20 ± 3.77	61.25 ± 2.86	40 – 55*
Eosonophils (%)	2.00 ± 0.71	1.48 ± 0.50	0 – 10*
Basophils (%)	0.20 ± 0.45	0.00 ± 0.00	0 – 3*
Monocytes (%)	1.20 ± 0.84	1.50 ± 0.87	0 – 6*
Mean Corpuscular Volume (fl)	21.80 ± 0.45	22.04 ± 0.87	28 – 40*
MCH (pg)	7.20 ± 0.45	7.50 ± 0.50	8 – 12*
MCHC (g/dl)	33.20 ± 0.45	33.76 ± 0.43	31 – 34*

* = Merck (2012), MCH = Mean Corpuscular Haemoglobin, MCHC = Mean Corpuscular Haemoglobin Concentration

Table 4: Serum biochemical parameters of WAD sheep reared semi-intensively during the dry season

Parameters	Female	Male	Reference Range
TP (g/dl)	6.72 ± 0.45	7.02 ± 1.48	6.0 - 7.9*
ALB (g/dl)	2.41 ± 0.04	2.26 ± 0.16	2.4 -3.0¢
GLO (g/dl)	4.31 ± 0.81	4.76 ± 1.47	3.5 – 5.7*
ALT (UI/L)	19.04 ± 0.19	21.13 ± 0.09	6 – 34¢

* = Merck (2012), ¢ = Ramin (2005), TP = Total protein; ALT = Alanine aminotransferase, GLO = Globulin, ALB = Albumin

These findings are consistent with research by Opara *et al*. (2010), which highlighted the impact of seasonal variations on hematological parameters in West African Dwarf sheep. Understanding these fluctuations is crucial for optimizing the health and productivity of these animals. The erythrogram of West African Dwarf sheep exhibited seasonal and sex-related variations. During the dry season, the red blood cell (RBC) count for both sexes remained within the reference range, with males displaying significantly higher counts than females (Alade *et al*., 2017). The elevated RBC count in males suggests an enhanced oxygen-carrying capacity, potentially providing them with an adaptive advantage in coping with environmental stressors during the dry season (Lawal-Adebowale *et al*., 2019). In contrast, during the rainy season, the RBC count was slightly below the reference value by Merck (2012), which may be due to breed differences or a response to environmental stressors, despite adequate packed cell volume (PCV) and hemoglobin (Hb) levels (Olabode *et al*., 2018). This finding suggests that that the animals are from immune challenge and/or diseases infection, despite the potentially low-quality feed available during the dry season. Seasonal variations in hematological and immunological parameters were observed in West African Dwarf sheep. During the dry season, neutrophil percentages were within the normal range, with females exhibiting slightly higher counts (Alade *et al*., 2017). This suggests a more active innate immune response in females, as neutrophils play a crucial role in defending against infections (Kumar *et al*., 2018). Lymphocyte percentages were slightly elevated above the reference range (Merck, 2012), indicating a potentially heightened adaptive immune response. This elevation might be attributed to ongoing immune responses due to subclinical infections or stress (Olabode *et al*., 2018). In contrast, during the rainy season, differential white blood cell (WBC) counts, including neutrophils, lymphocytes, eosinophils, basophils, and monocytes, remained within their respective reference ranges (Lawal-Adebowale *et al*., 2019). This suggests balanced immune cell populations and no signs of immune stress or disease. Regarding red blood cell indices, the dry season presented notable challenges.

Both sexes exhibited mean corpuscular volume (MCV) values below the normal range, indicative of microcytic anemia (Akinlade *et al*., 2015). This form of anemia is often linked to nutritional deficiencies, particularly iron, or chronic diseases as occasioned by low nutritive quality of available forages. Mean corpuscular hemoglobin (MCH) values were also below the reference range, suggesting hypochromic anemia, characterized by reduced hemoglobin content in red blood cells (Ogunbodede *et al*., 2017). In contrast, during the rainy season, MCV and MCH values were higher than the reference ranges, particularly in males, suggesting macrocytic and hyperchromic characteristics (Alade *et al*., 2017).

Table 5: Haematological parameters of sheep reared semi-intensively during the rainy season

Parameters	Female	Male	Reference range
Packed cell volume (%)	32.33 ± 6.66	34.67 ± 4.51	27 – 45*
Haemoglobin (g/dl)	10.73 ± 1.98	11.67 ± 1.37	9.0 – 15.0*
Red Blood Cell ($x10^{12}$/L)	5.80 ± 0.66	5.47 ± 0.76	9.0 – 15.0*
White Blood Cell ($x10^{9}$/ L)	6.20 ± 0.72	7.07 ± 2.00	4.0 – 8.0*
Neutrophils (%)	36.00 ± 5.29	33.67 ± 4.62	10 -50*
Lymphocyte (%)	62.33 ± 3.79	64.33 ± 3.79	40 – 55*
Eosonophils (%)	0.67 ± 1.16	0.67 ± 0.58	0 – 10*
Basophils (%)	0.00 ± 0.00	0.00 ± 0.00	0 – 3*
Monocyte (%)	1.00 ± 1.00	1.33 ± 0.58	0 – 6*
Mean Corpuscular Volume (fl)	55.34^{b} ± 5.55	65.04^{a} ± 4.72	28 – 40*
MCH (pg)	18.40^{b} ± 1.38	21.91^{a} ± 1.64	8 – 12*
MCHC (g/dl)	33.31 ± 0.95	33.69 ± 0.53	31 – 34*

* = Merck (2012), MCH = Mean Corpuscular Haemoglobin, MCHC = Mean Corpuscular Haemoglobin Concentration

Table 6: Serum biochemical parameters of WAD sheep reared semi-intensively during the rainy season

Parameters	Female	Male	Reference range
TP (g/dl)	4.57 ± 0.67	5.80 ± 1.47	6.0 - 7.9*
ALB (g/dl)	2.80 ± 0.72	2.29 ± 1.97	2.4 -3.0¢
GLO (g/dl)	1.70 ± 0.63	1.27 ± 0.38	3.5 - 5.7*
ALT (U/L)	29.67 ± 1.53	30.00 ± 3.61	26 -34¢

* = Merck (2012), ¢ = Ramin (2005), TP = Total protein; ALT = Alanine aminotransferase, GLO = Globulin, ALB = Albumin

Both sexes exhibited mean corpuscular volume (MCV) values below the normal range, indicative of microcytic anemia (Akinlade *et al*., 2015). This form of anemia is often linked to nutritional deficiencies, particularly iron, or chronic diseases as occasioned by low nutritive quality of available forages. Mean corpuscular hemoglobin (MCH) values were also below the reference range, suggesting hypochromic anemia, characterized by reduced hemoglobin content in red blood cells (Ogunbodede *et al*., 2017). In contrast, during the rainy season, MCV and MCH values were higher than the reference ranges, particularly in males, suggesting macrocytic and hyperchromic characteristics (Alade *et al*., 2017). This could be attributed to improved dietary intake, leading to larger red blood cells with higher hemoglobin content, or genetic factors influencing red blood cell morphology (Kumar *et al*., 2018). MCHC levels remained within the normal range for both sexes, indicating consistent haemoglobin content per unit volume of red blood cells, despite the changes in size and hemoglobin content of the cells.

Serum biochemical indices are crucial for assessing liver function, protein quality, and amino acid requirements in animals (Tamber *et al*., 2023). In this study, serum biochemical parameters did not differ significantly between sexes or seasons, although some parameters were increased numerically in male sheep. Total protein (TP) values were within the reference range (Merck, 2012). Males exhibited slightly higher total protein (TP) levels compared to females across both seasons. This finding is consistent with recent studies demonstrating sex-related differences in plasma protein concentrations (Kumar *et al*., 2020). Furthermore, plasma proteins, particularly albumin, play a crucial role in transporting calcium, phosphorus, and other essential nutrients in the blood (Wang *et al*., 2022). Albumin levels were slightly higher in females than males, with both sexes remaining within the reference range (Ramin, 2005). Globulin levels remained stable and within the normal range for both sexes during both seasons (Merck, 2012), indicating consistent immune function. Alanine aminotransferase (ALT) levels were within the normal range (Ramin, 2005) for both sexes across both seasons, with males showing slightly higher values than females. This finding is supported by recent studies (Alade *et al*., 2017; Olabode *et al*., 2018), which reported similar ALT levels in sheep.

CONCLUSION

It can be concluded based on the differences observed among the haematological and serum biochemical profiles of the ram and ewe during the dry and rainy season, that rams have better ability to adapt in the dry season while no major variation was observed in both ram and ewes blood profile during the rainy season.

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