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*Full Length Research*

# Haematological parameters of sheep in the semi-arid zone of North Eastern Nigeria

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**ABSTRACT:** Haematological parameters of sheep in the semi-arid zone of North-Eastern Nigeria were studied between August 2022 and April, 2023. Blood was sampled from one hundred and sixty-eight sheep comprising of Yankasa, Balami and Uda (56 per breed) at the Federal University Gashua Teaching and Research Farm, Gashua abattoir and Garin Alkali goats and sheep markets. The study was carried out to determine the blood profile of prominent indigenous sheep breeds in the study area. Blood samples were carefully collected from the animals into labeled sterile bottles containing Ethylene diamine tetra-acetic acid for haematological examination. Data analyzed for the effect of breed, sex and age were not significantly affected ($p>0.05$) for packed cell volume (PCV) and haemaglobin (Hb) concentration. Consequently, values of PCV and Hb differed significantly ($p<0.05$) with season in favour of wet season, (40.87%) and (13.63g/dl) for PCV and Hb respectively. Values for red blood cell (10.18 $x10^3$/µL), mean corpuscular hemoglobin concentration (35.11g/dl), mean corpuscular hemoglobin (12.71 Pg), mean corpuscular volume (45.86 Fl) and white blood cell (10.72 $x10^3$/µL) were significantly higher ($p<0.05$) for Uda sheep. Adult sheep generally had significantly ($p<0.05$) higher values for haematologic parameters considered. It was concluded that there were breed, sex, age and seasonal differences in haematological parameters of the sheep breeds studied. The blood parameters needed to be monitored frequently and appropriately controlled to ensure stability and adequate health and nutritional status of sheep.

**Keywords:** Haematological, parameters, sheep.

## INTRODUCTION

Sheep play important roles in the livestock subsector of the Nigerian agricultural economy (Abdulkarim and Aljameel, 2021). They are concentrated mostly in the northern dry-hot than in the southern humid parts of Nigeria. They serve primarily as sources of meat, but also provide milk and skin (FOA, 2020; Dagnachew *et al*., 2011). Blood is an important index of physiological and pathological changes in an organism (Addass *et al.*, 2010). The primary function of the blood is to transport oxygen from respiratory organs to body cells (Campbell, 2012) distributing nutrients and enzymes to cells and carrying away waste products (Njidda *et al.*, 2014) thereby maintaining homeostasis of the internal environment (Kaisar *et al.,* 2018). The various functions of the blood are carried out by the individual and collective actions of its constituents-the haemotological and biochemical components (Akinmutimi, 2004). Haematological tests have been widely used for the diagnosis of various diseases and nutritional status of animal. The information gained from the blood parameters would substantiate the physical examination and together with medical history provide excellent basis for medical judgment (Campbell, 2004). In addition, it would help to determine the extent of tissue and organ damage, the response of defense mechanism of the patient and aid in the diagnosing the type of possible anaemia (Campbell, 2012). Physiological and pathological changes can be best evaluated when normal blood values are available for comparison. This study is therefore an attempt to come up

with normal hematological reference values in indigenous sheep breeds found in the semiarid zone of Nigeria raised under free ranged system as influenced by breed, sex and age.

## MATERIALS AND METHODS

### Area of the study

The study was conducted in Gashua, Bade Local Government Area, Yobe state, located in North-Eastern Nigeria. Bade Local Government is bordered by five Local Government areas of Yobe State as follows: Jakusko, Dapchi, Karasuwa, Yusufari and Nguru. The area is situated in semi-arid sub-Saharan region of North Eastern Nigeria on latitude 12° 42' 58" and longitude 10° 38' 36". The study area experiences averagely low level of rainfall annually over decades. During these periods, the area suffered series of drought. Although in recent years, there is an observed increasing average rainfall trends but this was accompanied by higher average temperatures of between 48-40°C.

### Breeds of sheep used

Three breeds of indigenous sheep found in Nigeria and available in Gashua, Yobe State were used for this study. They include: Yankasa, Balami and Uda. They were made available from Gashua environs, abbatoir and, sheep and goat markets.

### Study design and sampling

The study was carried out between August 2022 and April 2023 where random blood samples were collected from 168 sheep consisting of 56 from each of Yankasa, Balami and Uda breeds. Equal number of samples was collected from female and male sheep across breed. The samples were collected from Gashua environs, abbatoir, and sheep and goat markets. The total sample size was estimated according to Thrusfield (2005) using 95% confidence and expected prevalence of 89.1% from previous study of James (2014) and desired precision of 5% as follows:

$n = 1.96^2 P_{exp} \quad (1- P_{exp})/d^2$

Where n = sample size, $P_{exp}$ = expected prevalence (89.1% of James, 2014), d = desired absolute precision of 5% (0.05).

$n = 1.96^2 \times 0.891 (1-0.891)/ (0.05)^2$

$n = 3.8416 \times 0.891(0.109)/ 0.0025$

$n = 0.3731/ 0.0025$

n = 150 samples approximately

Stratified random sampling was applied to collect the samples from Yankasa, Balami, and Uda sheep used.

### Blood sample collection and analysis

Blood samples (5 ml per animal) were obtained from the jugular vein using a 10 ml syringe attached to 21gauge x ½ inch needle. Air was first cleared from the syringe before puncturing at 20° angle (Pratt, 1985) and the syringe was aspirated to confirm insertion and collection of blood. The blood samples collected was then placed in tubes coated with ethylene-diamine tetra-acetic acid (EDTA) as anticoagulant. The samples were adequately labeled and taken to Federal Teaching Hospital's Haematology Laboratory for analysis.

### Packed cell volume

Capillary tubes method was used for the PCV measurement. After centrifugation of the prepared capillary tubes at 10000 - 15000 gravity for 5 minutes, the PCV value was read using a reader (Pratt, 1985).

### Red cell distribution

The red cell distribution (RCD) was determined thus;

The coefficient of variation of red blood cell was determined using the analyser. Coefficient of variation (CV) of RDW was used to calculate for RDW as:

RDW (CV %) = Standard deviation of RBC size X 100/ MCV.

### Haemoglobin concentration determination

Haemoglobin concentration was determined using the cyan-methemoglobin method. Twenty-four empty test tubes were assembled in a rack including an extra tube for blank. Five millilitre of cyanide was poured into each test tube followed by 0.02 ml of individual blood samples except the blank. The tubes were thoroughly mixed and allowed to stand for not less than 3 minutes after which haemoglobin concentration was read using the electronic colorimeter. The colorimeter was first zeroed using the blank and both the fine and coarse adjusters. Subsequently the absorbances of the samples were recorded. The final results were obtained using the Hb reference table (Mitruka and Rawnsley, 1977).

### Red blood cell count

An automatic pipette was used to dispense 4 ml of RBCs diluting fluid into a clean and dry tube. Thereafter 0.2 µl of blood sample was added and thoroughly mixed. The mixture was allowed to stand for 5 minutes after which the Nauber chamber was charged. The charging entails first, proper cleaning of the surface of the chamber to clear dust particles which often form artifacts. A clean cover slip was properly fitted on to the chamber, the mixture was stirred and an aliquot collected and gently dispensed "charging" from one edge under the cover slip, carefully avoiding passage of bubbles. The charged chamber was then placed under the microscope and read at low magnification (x10). Only red blood cells found within the primary/secondary and tertiary squares at the centre of the Nauber chamber were counted and recorded.

### White blood cell count

Blood was first drawn to fill the WBC haemocytometer pipette to the 0.5 mark. The tip of the pipette was cleaned and the WBC diluting fluid drawn to the 1.1 mark and mixed gently avoiding bubbles formation. A cover slip was placed appropriately on the counting chamber of the haemocytometer. The fluid-blood mixture was then transferred using a fine bore pipette in to the counting chamber. It was ensured that the mixture did not overflow. After about 2 minutes when the cells had settled to the bottom, the charged chamber was placed under the microscope and viewed using the low power objective (x10). The WBCs uniformly observed in the four larger corner squares were counted. Cells present on the outermost lines were counted on one side and those present on the line opposite were avoided.

### Thin blood smears techniques for differential count

A thin blood smear was made by placing a drop of blood at one end of a clean slide and with a spreader; the blood was swiftly spread down the slide. Adequate volume of methanol was used to fix the smear onto the slides for 5 minutes. A reconstituted Geimsa stain in the ratio of 1:100 ml of distilled water was used to cover the entire surface of the fixed slides. The stain was allowed for 10 minutes after which it was washed out with laboratory jets of water. The already stained slides were left to dry and then packed. Using an oil immersion microscope, at least 100 cells were counted by moving the slide in a systematic fashion as to include the central and peripheral areas of the smear. The laboratory cell counter was used to count each of the leucocytes and lymphocyte (Eberhard and Lammie, 1991).

## RESULTS AND DISCUSSION

### Effect of breed, sex, age and season on haematogical parameters

Averages of haematological parameters by breeds were as presented in Table 1. There was significant breed effect on white blood cell (WBC), mean corpuscular haemaglobin concentration (MCHC), mean corpuscular volume (MCV) and lymphocyte (LYM) ($p<0.05$), mean corpuscular haemoglobin (MCH) and red blood cell (RBC) ($p<0.05$). However, there was non-significant breed influence on packed cell volume (PCV) and haemaglobin concentration (Hb). The significant variation in WBC, RBC, MCV, MCH, MCHC and LYM by breed observed in this present study is in agreement with the reports of Kaneko *et al*. (2008) and Nafisat *et al*. (2021).

Uda had the highest RBC (10.18 x $10^3$ / µL) and MCHC (35.11 x $10^3$ / µL) while the values for Yankasa and Balami were comparable. Lymphocyte (71.68%) was highest in Yankasa and recorded least (57.00%) in Uda. The values for MCV in Balami (41.48 Fl), Yankasa (4.55 Fl) and Uda (45.86 Fl) were comparable while WBC (11.58 x$10^3$/µL) was highest in favour of Balami.

The higher RBC and MCHC values in Uda than other breeds have also been reported by Mbassa and Poulsan (2008) and Nafisat *et al.* (2021). However, the higher value for WBC reported in the present study in favour of Balami than the other breeds disagree with the finding of Agbaye *et al*. (2021) who reported higher values of MCV, MCH, MCHC and WBC in favour of Yankasa and Uda than Balami; the variations however, could be due to location.

Average heamatological parametes by sex also presented in Table 1, revealed significant ($p<0.05$) effect of sex on RBC, MCHC, MCH, WBC and LYM. Females had higher RBC (9.74 x$10^3$/ µL) than males. Conversely, higher ($p<0.05$) MCHC (35.36 g/dl), WBC (11.29 x$10^3$/ µL) and LYM (68.23 %) were reported in favour of males. However, the effect of sex on the other haematological parameters was not significant.

In the present study, that RBC was affected by sex in favour of female sheep agrees with the report by Nafisat *et al.* (2021) and Fantu *et al*. (2012). The variation however could be due to hormonal difference (Njidda *et al*., 2014). Also, that value of MCHC, WBC and LYM favours the male sheep agrees with Tambuwal *et al*. (2002).

Average haematological parameters by season as presented in Table 1, indicated significant ($p<0.05$) influence of season on PCV, HB and WBC. The values for PCV and HB were higher in wet than dry season. Conversely, WBC (11.18 x$10^3$/µL) was significantly higher ($p<0.05$) in dry. However, the other haematological parameters were not significantly influenced by season.

The report in this present study that PCV, HB, WBC, and

**Table 1.** Effect of breed, sex, age and season on haematological parameters.

| Category | Parameters | PCV | | Hb | | RBC | | MCHC | | MCH | | MCV | | WBC | | LYM | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\bar{X}$ | *Se* | $\bar{X}$ | Se | $\bar{X}$ | Se | $\bar{X}$ | Se | $\bar{X}$ | Se | $\bar{X}$ | Se | $\bar{X}$ | Se | $\bar{X}$ | Se |
| Breed | Level of significant | Ns | | Ns | | * | | * | | * | | * | | * | | * | |
| | Yankasa | 40.00 | ±10.14 | 12.87 | ±1.54 | $9.19^{b}$ | ± 0.43 | $31.70^{b}$ | ±8.13 | $12.76^{a}$ | ±0.13 | $44.55^{a}$ | ±7.27 | $11.28^{b}$ | ±2.61 | $71.68^{a}$ | ±15.97 |
| | Balami | 39.17 | ±10.14 | 12.77 | ±1.54 | $9.26^{b}$ | ± 0.43 | $31.99^{b}$ | ±8.13 | $12.51^{b}$ | ±0.14 | $41.48^{a}$ | ±7.27 | $11.58^{a}$ | ±2.61 | $69.33^{a}$ | ±15.97 |
| | Uda | 37.97 | ±10.14 | 12.60 | ±1.54 | $10.18^{a}$ | ±0.43 | $35.11^{a}$ | ±8.13 | $12.71^{b}$ | ±0.13 | $45.86^{a}$ | ±7.27 | $10.72^{b}$ | ±2.61 | $57.00^{b}$ | ±15.97 |
| Sex | Level of significant | Ns | | Ns | | * | | * | | * | | Ns | | * | | * | |
| | Male | 39.51 | ±10.14 | 12.81 | ±1.54 | $9.34^{b}$ | ±0.42 | $35.36^{a}$ | ±8.13 | $12.24^{b}$ | ±0.11 | 44.67 | ±7.27 | $11.29^{a}$ | ±2.61 | $68.23^{a}$ | ±15.97 |
| | Female | 38.58 | ±10.14 | 12.68 | ±1.54 | $9.74^{a}$ | ±0.42 | $31.50^{b}$ | ±8.13 | $12.74^{a}$ | ±0.11 | 44.19 | ±7.27 | $11.23^{b}$ | ±2.61 | $63.80^{b}$ | ±15.97 |
| Age | Level of significant | Ns | | Ns | | * | | * | | * | | * | | * | | * | |
| | Adult | 39.15 | ±10.14 | 12.71 | ±1.53 | $10.19^{a}$ | ±0.42 | $35.35^{a}$ | ±8.13 | $12.09^{b}$ | ±0.11 | $42.23^{b}$ | ±7.27 | $11.60^{a}$ | ±2.61 | $68.87^{a}$ | ±15.97 |
| | Young | 38.94 | ±10.14 | 12.79 | ±1.53 | $9.89^{b}$ | ±0.42 | $31.52^{b}$ | ±8.13 | $12.90^{a}$ | ±0.11 | $46.63^{a}$ | ±7.27 | $10.92^{b}$ | ±2.61 | $63.14^{b}$ | ±15.97 |
| Season | Level of significant | * | | * | | Ns | | Ns | | Ns | | Ns | | * | | Ns | |
| | Dry | $37.22^{b}$ | ±10.14 | $11.87^{b}$ | ±1.53 | 9.33 | ±0.42 | 31.70 | ±8.13 | 12.78 | ±0.11 | 44.68 | ±7.27 | $11.18^{a}$ | ±2.61 | $65.05^{a}$ | ±15.97 |
| | Wet | $40.87^{a}$ | ±10.14 | $13.63^{a}$ | ±1.53 | 9.75 | ±0.42 | 31.66 | ±8.13 | 12.81 | ±0.11 | 44.18 | ±7.27 | $11.34^{b}$ | ±2.61 | $66.96^{a}$ | ±15.97 |

WBCs = White blood cells ($x10^3$/µL); RBCs = Red blood cells ($x10^3$/µL); PCV = Packed Cell Volume (g/dl); HB = Haemoglobin (g/dl); MCV = Mean corpuscular volume (Fl); MCH = Mean corpuscluar heamoglobin (Pg); MCHC = Mean corpuscular haemoglobin concentration (g/dl); LYM = Lymphocyte (%); Ns = Not- Significant; * = P<0.05; abc = Means with different superscripts on the same row differ significantly.

LYM were significantly affected by season has been similarly reported by Mbassa and Poulsan (2003), Nafisat *et al.* (2021) and Fantu *et al.* (2012). The PCV, HB and LYM exhibited higher values in the wet than dry season which disagrees with Koubkova *et al*. (2002) who reported higher values for PCV, HB and LYM in favour of dry season. The significant seasonal influence on PCV and HB in the wet season exhibiting higher values agrees with Bilbo and Nelson (2001) and Fantu *et al*. (2012). The wet season is the period of lush pasture which has positiveinfluence on PCV, and HB which tend to increase with better nutrition (Waruiru *et al*., 2004; Pathak and Pal, 2008).

The average haemotological parameters by age are shown in Table 1. There was significant (p<0.05) age effect on RBC, WBC, MCHC, MCV and MCH while PCV and HB were not significantly influenced. Adults had higher RBC, MCHC, WBC and LYM values 10.19 $x10^3$/µL, 35.35 g/dl, 11.60 $x10^3$/µL and 68.87% respectively. The significant age influence on RBC, MCHC, WBC and LYM in this study in favour of adult sheep agrees with findings of Michell and John (2008). The higher values in MCHC and WBC observed in this study suggest a well-developed immune system in adult sheep than in young which has similarly been reported by Njidda *et al*. (2014) that immune system in sheep increases with age.

## Interaction effect of haematological parameters by breed, age and season

### *Breed x age*

Table 2 depicts breed x age interaction effect on the haematological parameters. There was significant (p<0.05) breed x age interaction effect on all the haematological parameters. Balami adult and young Yankasa breeds had the highest PCV values; 42.50% each while the least was observed

**Table 2.** Interaction effect of haematological parameters by breed, age and season.

| Category | Parameters | PCV | | Hb | | RBC | | MCHC | | MCH | | MCV | | WBC | | LYM | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\bar{X}$ | *Se* | $\bar{X}$ | Se | $\bar{X}$ | Se | X | Se | $\bar{X}$ | Se | $\bar{X}$ | Se | $\bar{X}$ | Se | $\bar{X}$ | Se |
| Breed x Age: | Level of significant | * | | * | | * | | * | | * | | * | | * | | * | |
| | Yankasa | 37.95$^{b}$ | ± 0.60 | 12.21$^{b}$ | ±0.23 | 10.30$^{a}$ | ±0.12 | 34.51$^{a}$ | ±0.53 | 10.36$^{c}$ | ±0.19 | 40.39$^{c}$ | ±1.55 | 21.09$^{b}$ | ±0.48 | 74.62$^{a}$ | ±0.75 |
| Adult | Balami | 42.50$^{a}$ | ±0.61 | 13.51$^{a}$ | ±0.23 | 9.91$^{b}$ | ±0.12 | 33.53$^{b}$ | ±0.53 | 11.23$^{b}$ | ±0.19 | 56.66$^{b}$ | ±1.58 | 26.44$^{a}$ | ±0.49 | 67.70$^{b}$ | ±0.75 |
| | Uda | 37.17$^{b}$ | ± 0.60 | 12.36$^{b}$ | ±0.23 | 9.98$^{b}$ | ±0.12 | 34.76$^{a}$ | ±0.53 | 10.68$^{c}$ | ±0.19 | 43.23$^{bc}$ | ±1.55 | 25.33$^{a}$ | ±0.48 | 64.37$^{b}$ | ±0.75 |
| | Yankasa | 42.50$^{a}$ | ±0.60 | 13.53$^{a}$ | ±0.23 | 9.09$^{b}$ | ±0.12 | 31.88$^{c}$ | ±0.53 | 12.15$^{a}$ | ±0.19 | 88.73$^{a}$ | ±1.55 | 21.47$^{b}$ | ±0.48 | 68.74$^{b}$ | ±0.75 |
| Young | Balami | 35.99$^{c}$ | ±0.60 | 11.98$^{c}$ | ±0.23 | 9.77$^{b}$ | ±0.12 | 31.70$^{c}$ | ±0.53 | 10.79$^{c}$ | ±0.19 | 66.60$^{b}$ | ±1.55 | 26.02$^{a}$ | ±0.48 | 71.04$^{a}$ | ±0.75 |
| | Uda | 38.77$^{b}$ | ±0.60 | 12.85$^{b}$ | ±0.23 | 9.89$^{b}$ | ±0.12 | 34.46$^{a}$ | ±0.53 | 11.74$^{b}$ | ±0.19 | 48.50$^{b}$ | ±1.55 | 4.97$^{c}$ | ± 0.48 | 49.64$^{c}$ | ±0.75 |
| Breed x Season: | Level of significant | * | | * | | * | | * | | * | | * | | * | | * | |
| | Yankasa | 38.58$^{b}$ | ±0.60 | 11.92$^{b}$ | ±0.23 | 9.52$^{c}$ | ±0.12 | 33.26$^{b}$ | ±0.53 | 12.92$^{a}$ | ±0.19 | 64.21$^{a}$ | ±1.55 | 20.90$^{b}$ | ±0.48 | 70.98$^{a}$ | ±0.75 |
| Dry | Balami | 37.06$^{b}$ | ±0.60 | 11.92$^{b}$ | ±0.23 | 9.53$^{c}$ | ±0.12 | 32.52$^{c}$ | ±0.54 | 11.61$^{b}$ | ±0.20 | 61.12$^{b}$ | ±1.55 | 25.81$^{a}$ | ±0.49 | 68.82$^{b}$ | ±0.77 |
| | Uda | 36.18$^{c}$ | ±0.60 | 11.95$^{b}$ | ±0.23 | 10.10$^{a}$ | ±0.12 | 34.06$^{a}$ | ±0.53 | 12.71$^{a}$ | ±0.19 | 45.52$^{c}$ | ±1.55 | 14.60$^{c}$ | ±0.48 | 55.42$^{c}$ | ±0.75 |
| | Yankasa | 41.42$^{a}$ | ±0.60 | 13.82$^{a}$ | ±0.23 | 9.87$^{b}$ | ±0.12 | 33.14$^{b}$ | ±0.53 | 12.93$^{a}$ | ±0.19 | 64.89$^{a}$ | ±1.55 | 21.66$^{b}$ | ±0.48 | 72.38$^{a}$ | ±0.75 |
| Wet | Balami | 41.43$^{a}$ | ±0.60 | 13.81$^{a}$ | ±0.23 | 9.83$^{b}$ | ±0.12 | 33.19$^{b}$ | ±0.54 | 11.41$^{b}$ | ±0.19 | 62.14$^{b}$ | ±1.55 | 26.65$^{a}$ | ±0.48 | 69.93$^{b}$ | ±0.75 |
| | Uda | 39.77$^{b}$ | ±0.60 | 13.25$^{a}$ | ±0.23 | 10.25$^{a}$ | ±0.12 | 34.17$^{a}$ | ±0.53 | 11.41$^{b}$ | ±0.19 | 46.21$^{c}$ | ±1.55 | 15.70$^{c}$ | ±0.48 | 58.58$^{c}$ | ±0.75 |

WBCs = White blood cells (x10$^{3}$/µL); Ns = Not-significant; RBCs = Red blood cells (x10$^{3}$/µL); * = P<0.05; PCV = Packed Cell Volume (g/dl); HB = Haemoglobin (g/dl); MCV = Mean corpuscular volume (Fl); MCH = Mean corpuscluar heamoglobin (Pg); MCHC = Mean corpuscular haemoglobin concentration (g/dl); LYM = Lymphocyte (%); abc = Means with different superscripts on the same row differ significantly.

in young Balami (35.99%). For HB, young Yankasa had the highest value 13.53 g/dl, while young Balami had the least 11.98 g/dl. The mean values for PCV and HB for young Balami and young Yankasa falls within the reference range as agreed by Nafisat *et al.* (2021) and Ajayi *et al*. (2021). This suggested that the animals are apparently healthy and will not be susceptible to anemia.

For RBC, higher value was observed in adult Yankasa (10.30 x10$^{3}$/µL) while the least was recorded in young Balami (9.77 x10$^{3}$/µL). For WBC, adult Balami had the highest WBC value (26.44 x10$^{3}$/µL) followed by young Balami (26.02 x10$^{3}$/µL) and Uda adult (25.33 x10$^{3}$/µL) while the least value for WBC was recorded in younger Uda (4.97 x10$^{3}$/µL). Values for RBC and WBCs among breed and age interaction in the present study fall within reference range reported by Ajayi et al. (2021) for hematological profile for indigenous sheep.

Values for LYM (%) were however highest (74.62) in adult Yankasa while the least was recorded in young Uda (49.64). The mean value for lymphocyte 74.62% in adult Yankasa agrees with the report by Ajayi *et al*. (2021). However, the mean value of lymphocyte above the reference range in this study may be attributed to normal body response to an infection or inflammatory condition as reported by Ajayi *et al*. (2021) and Agbaye *et al.* (2021). Yankasa young, Balami young, Balami adult and Uda adult breeds had values within the reference range which indicates proper immune functioning while those above the normal range is an indication of parasitic infection as agreed by Campbell (2012). Thus, interaction effect between breed and age all had values fall within the reference range.

Higher values for MCH were recorded in young Yankasa 12.15 Pg, and the least was observed in

adult Yankasa 10.36 Pg. For MCHC, higher values were recorded in adult Yankasa 34.51 g/dl followed by Uda young 34.46 g/dl and Uda adult 34.76 g/dl while the least was observed in young Yankasa 31.88 g/dl. Values for MCV were recorded highest in young Yankasa (88.73 Fl) while the least was observed in adult Yankasa (40.39 Fl) and young Uda (43.23 Fl).

Similarly, values for LYM, MCH, MCHC and MCV by breed and age interaction in the present study, fall within the reference range as corroborated by Kaisar *et al.* (2018) and Ajayi *et al*. (2021).

Conversely, report of hematological parameters by breed and age interaction reported in this study generally disagrees with the report of Ajayi *et al*. (2021) who reported hematological values mostly below reference range. This however, may be attributed to low adaptability of the animals to their diet thereby leading to decline in nutrient absorption as they aged.

***Breed x season***

Table 2 depicts breed x season interaction effect on the haematological parameters. There was significant breed x season interaction effect on all the haematological parameters. Balami had the highest PCV value 41.43% followed by Yankasa 41.42 % in favour of wet season while the least was observed in Uda 36.18 % in dry season which corresponds with the report of Bukar *et al.* (2020) and Addass *et al*. (2010). That the value WBC was highest 26.65 x $10^3$ /µL during the wet season in favour of Balami while Uda had the least 14.60 x $10^3$ /µL in the dry season was also in agreement with the finding of Fatin *et al.* (2022). Similarly, Yankasa had the highest HB value 13.82 g/dl in wet season followed by Balami 13.81 x $10^3$ /µL and Uda 13.25 x $10^3$ /µL while the other groups have similar values. Uda also had the highest RBC value 10.25 x $10^3$ /µL in favour of wet season while the least was recorded in Yankasa 9.52 x $10^3$ /µL during dry season. The values of HB and RBC recorded across breed and season in the present study agrees with the reports of Fatin *et al.* (2022) and Ajayi *et al*. (2021). The highest value for MCH was recorded during the wet season in favour of Yankasa 12.93 Fl and the lowest were observed in Balami and Uda 11.41 Fl each in wet season while values for the other categories were comparable is in congruence with the findings of Kaisar *et al.* (2018).

Also, the report that the value of MCHC was highest in wet season in favour of Uda 34.17 g/dl while the lowest was observed in Balami 32.52 g/dl during the dry season agrees with the report of Oregon State University (2018). Similarly, value for MCV was highest 64.89 Pg during wet season in favour of Yankasa while the least was recorded in Uda 45.52 Pg during dry season agrees with the report by Nafisat *et al.* (2021) while values for LYM were however highest 72.38% during the wet season in favour of Yankasa and least 55.42% in Uda during the dry season which is in agreement with the findings of Fatin *et al*. (2022) and Abdulkarim and Aljameel (2021).

## Conclusion/Recommendation

From the present study, it can be concluded that the haematological parameters for sheep studied fall mostly within normal range. Age, sex, breed and season showed remarkable influence on the haematological indices of sheep in the study area; and the observed variations could be due to nutritional genetic and environmental effect. Therefore, blood parameters needed to be monitored frequently and appropriately controlled to ensure stability and adequate health and nutritional status of sheep.

## CONFLICT OF INTEREST

The authors declare that they have no competing interests.

## REFEREENCES


Abdulkarim, A., & Aljameel, K. M. (2021). Assessing the haematology and serum chemistry of Uda rams fed different Kanwa based mineral licks. *Journal of Animal Science and Veterinary Medicine,* 6(6), 209-215.

Addass, P. A., Perez, I. K. A., Midau, A., Lawan, A. U., & Tizhe, M. A. (2010). NHaemato-Biochemical Findings of Indigenious sheep breeds in Mubi Adamawa State, Nigeria. *Global Veterinaria,* 4(2), 164-167.

Agbaye, F. P., Sokunbi, A. O., Onigemo, M. A., Alaba, O., Anjola, O. A. J., Amao, E. A., Agbalaya, K. K., Oso, Y. A. A., Ishola, O. J., Tijani, L. A., & Timothy, T. (2021). Blood profile of prevalent sheep breeds in Nigeria: A case study of Ikorodu Local Government Area of Lagos State, Nigeria. Nigerian Journal of Animal Production, *48*(5), 293-299

Ajayi, F., Olubukola, I., Martha, N., & Onyechukwu, J. E. (2021). Analysis of genetic and non- genetic factors affecting hematology and biochemical parameters of Nigerian indigenous sheep. *Nigerian Journal of Animal Science*, 23(3), 24-38.

Akinmutimi, A. H. (2004). Evaluation of sword bear (*Canavalia gladiate*) as an alternative feed resources for broiler chickens. Ph. D Thesis Michael Okpara University of Agriculture, Umudike, Nigeria.

Nafisat, A., Boyi, B., Mbap, S. T., Elizabeth, T., Ibrahim, Y., Ja'afar, A. M., & Shuaibu, A. (2021). Effect of breed, sex, age and season on the haematological parameters of sheep in Bauchi state, Nigeria. *Nigerian Journal of Animal Science*, *23*(2), 28-37.

Bilbo, S. D., & Nelson, R. J. (2001). Sex steroids hormones enhance immune functions in male and female hamsters. *American Journal of Physiological Regulation*, 280, 207-213.

Bukar, A. I., Umaru, U. A., Muhammad, N. Aljameel, K. M., Abdulkarim, A., Abubakar, Y. M., Kabiru, N., Jaji, I. M., & Dilala, M. A. (2020). Evaluation of hematology and serum biochemistry of Uda rams fed graded levels of two forms of

*Kanwa*. *Global Scientific Journal*, *8*(9),1805-1899.
Campbell, T. W. (2012). *Veterinary hematology and clinical chemistry*. 2nd edition. John Wiley and Sons Inc. USA. Pp. 238-276.
Campbell, T. W. (2004). Haematology of birds. In: Thrall, A. T., Baker, D. C., Campbell, T. W., DeNicola, D., Fettman, M., Duane, L. E., Rebar, A., & Weiser, G. (eds). *Veterinary haematology and clinical biochemistry*. Lippincott, Williams and Wilkins, Baltimore. Pp. 225-258.
Dagnachew, S., Amamute, A., & Temesgen, W. (2011). Epidemiology of gastro intestinal helminthiasis of small ruminants in selected sites of North Gondar zone, Northwest Ethiopia. *Ethiopia Veterinary Journal,* 15, 57-68.
Eberhard, M. L., & Lammie, P. J. (1991). Laboratory diagnosis of filariasis. *Clinics in Laboratory Medicine*, *11*(4), 977-1010.
Food and Agricultural Organization (FAO) (2020). State of the world's animal resources for food and agriculture. Food and Agricultural Organization. P. 512.
Fatin, K., Harinath, Y., Zainab, A. B., & Ronia, J. (2022). Seasonal effects on growth, physiology, haematology and biochemical profiles of Naeemi Sheep breed. *Advances in Animal and Veterinary Science,* 10(10), 2160-2170.
Fantu, A. K., Yacob, H. T., & Gezahegn, M. K. (2012). Experimental infection of Ethiopian highland sheep by different infective doses of *Haemonchus contortus* (L3): haematological and parasitological parameters, serum protein concentrations and clinical responses. *Ethiopian Veterinary Journal, 16*(1), 41-57.
James, G. J. (2014). Studies on gastrointestinal helminths of small ruminant slaughtered in Dogarawa Slaughter Slab in Zaria, Nigeria, Nigeria. *Msc. Thesis, Faculty of Veterinary Medicine, Ahmadu Bello University Zaria*.
Kaisar, R., Shariful, I., Jinnat, F., Md. Helal, U., Muhammad, B. H., Mohammad, M. H., & Ariful, I. (2018). Determination of hematological and serum biochemical reference values for indigenous sheep (*Ovies aries*) in Dhaka and Chittagong Districts of Bangladesh. *Veterinary World*, *11*(8), 1089-1093.
Kaneko, J. J., Harvey, J. W., & Bruss, M. L. (2008). *Clinical biochemistry of domestic animals*. 6th edition. Academic Press; San Diego (USA). 916p.
Koubkova, M., Knizkova, L., Kunc, P., Hartlova, H., Flusser, J., & Dolezal, O. (2002). Influence of high environmental temperatures and evaporative cooling on some physiological, hematological and biochemical parameters in high-yielding dairy cows. *Czech Journal of Animal Science*, *47*(8), 309-318.
Mbassa, G. K., & Poulsen, J. S. D. (2003). Reference ranges for clinical chemical values in Landrace goats. *Small Ruminant Re*source, 10(2), 133-142.
Mitruka, B. M., & Rawnsley, H. M. (1977). *Clinical biochemical and hematological reference values in normal experimental animals*. Massion Publishing, USA. Pp. 42-47.
Njidda, A. A., Shuaiabu, A. A. and Isidahomen, E. C. (2014). Haematological and serum biochemical indices of sheep in Semi-Arid environment of Northern Nigeria. *Global Journal of Science Frontier Research*, 14(2), 2249-4626.
Pathak, A. K., & Pal, S. (2008). Seasonal prevalence of gastrointestinal parasites in goats from Durg district of Chhattisgarh. *Veterinary world*, *1*(5), 136.
Pratt, W. P. (1985). *Laboratory procedures for animal health technician*s. 1st edition, American Veterinary Publication Inc.
Tambuwal, F. M., Agale, B. M., & Bangana, A. (2002). Haematological and biochemical values of apparently healthy Red Sokoto goats. *Proceeding of the 27th Annual Conference of the Nigerian Society for Animal Production*, 3rd – 7th October, 2002.
Thrusfield, M. (2005). *Veterinary epidemiology*. 2nd edition. Blackwell Science Limited, Oxford, United Kingdom, Pp.182-198.
Waruiru, R. M., Ngotho, J. W., & Mutune, M. N. (2004). Effect of urea-molasses block supplementation on grazing weaner goats naturally infected with gastrointestinal nematodes. *Onderstepoort Journal of Veterinary Research*, *71*(4), 285-289.