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Effect of breed, sex, age and season on the haematological parameters of sheep in Bauchi state, Nigeria

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***Target Audience:** Farmers, Researchers, Animal Geneticist and Breeders*

Abstract

Haematology of sheep in Bauchi, Nigeria was assessed between February and September, 2017. Blood samples were collected from one hundred and twenty sheep comprising Yankasa, Balami, Ouda (32 per each breed) and West Africa Dwarf (24) at the Abubakar Tafawa Balewa University Research Farm, Muda Lawal, Durum and Gwallaga markets. Most haematological parameters namely; white blood cells (WBC), red blood cells (RBC), haemoglobin concentration (HB), lymphocyte (LYM), neutrophil (P<0.05) were significantly affected by breed P<0.05 and P<0.001 respectively. The highest values for haemoglobin concentration (9.83±0.39 g/dl), red blood cells count (8.03±0.27 x10^3/µl) and platelets (65.93±1.49 x10^3/µl) were recorded in Balami. Similarly, Mean Corpuscular haemaglobin concentration (32.56±1.96g/dl) and Neutrophil (41.80±2.34%) were highest in West African Dwarf while Uda had the highest red cell distribution (17.74.±0.32 fL). Red blood cells (23.17±5.43 fL) and red blood cells distribution (17.30±0.25 fL) were higher in female sheep than in their male counterpart. Red blood cells (8.02±0.26fL), HB (9.68±0.26 g/dl) and LYM (69.99±2.06%), exhibited higher values in the dry season while the values of WBCs (33.18±6.56 10^3/µl), mean corpuscular haemaglobin (13.23±0.33g/dl) and neutrophil (38.81±2.41%) were higher in wet season. The values of mean corpuscular haemaglobin (13.26±0.30 Pg), mean corpuscular haemaglobin concentration (30.97±0.92 g/dl), platelets (66.30±1.09 10^3/µl) and LYM (24.84±6.40 x10^3/µl) were higher in adult than young. 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:** Sheep, haematology, breed, season, sex and age*

Description of Problem

Small ruminants such as sheep and goats play important roles in the livestock subsector of the Nigerian agricultural economy [1]. In Nigeria, sheep contribute about 50% of the total domestically produced meat [1]. A flock of 50 sheep can provide a family of 25 with food each day in the form of meat and milk. Apart from provision of food and skin, sheep production plays a crucial role in socio-economic changes such as improvement in income and quality of life [2].

Sheep thrive in a wide variety of environments in the tropics and sub tropics and requires less capital as they can be completely maintained on pastures, browse and agricultural waste products [1]. Blood

properties reveal the physiological and pathological status of animals [3]

Life of animals is in their blood; their blood constituents therefore, determine their well-being [4].

The blood constituents of sheep in general have been fairly well studied in the developed world and also in some locations in Nigeria [6; 7]. There is however scant information from most parts of Nigeria; particularly the north east. In the Bauchi zone, work on this aspect is virtually non-existent. Since blood compositions vary due to different causes, extrapolation of information from elsewhere and from other species and breeds would hardly be meaningful. Studies have to be environment specific to be useful. Haematological values, when available, particularly the normal ranges will be helpful for comparisons in the face of diseases and nutritional scarcity which are common features in the study area. Farmers and sheep production specialists will be able to use available data to take appropriate intervention measures to ensure that high quality sheep of good health are kept / available.

The main objective of the study is to assess the haematology of sheep in Bauchi**.** The specific objective however is to determine the effects of breed, sex, age and season on the haematological parameters.

Materials and Methods

Area of the Study

The study was conducted in Bauchi and environs between March and September, 2017. Samples were collected from Abubakar Tafawa Balewa University Teaching and Research Farm, Durum and Muda Lawal markets Bauchi for both dry (between November to May) and wet (between June to October) seasons. Bauchi State occupies 49,119 km^2 representing about 5.3% of Nigeria's land mass and it is located between latitude 10.314159, and longitude 9.846282. Bauchi, Nigeria is located within the GPS coordinates of 10° 18' 50.9724" N and 9° 50' 46.6152" E and at an altitude of 628m above sea level [7]. It is bordered by seven states, Kano and Jigawa to the north, Taraba and Plateau to the south, Gombe and Yobe to the east and Kaduna to the west.

Climate, Soils and Vegetation

The rainfalls in Bauchi state range between 1300 mm per annum in the south and only 700 mm in the extreme north [8]. The rains are usually due to the moisture laden south westerly winds. The rains therefore start earlier (April) in southern part of the state and vary to June and July in the northern areas. The average relative humidity, daily sunshine hours and temperature values range between 35 and 94 % for the months of February and August, 5.0 and 10.0 hours in August and November and 36.6 to 12.8^0 C from April to December, respectively [8].

The soils are composed of ferruginous types on crystalline rocks, and, lithosol and juvenile formation on Aeolian sand [9]. Bauchi state spans three vegetation zones, namely, northern guinea, Sudan and Sahel savannahs [7; 9].

Field Sheep Management

Sheep (which were the animal used for the study) are mostly reared by the nomadic Fulanis and are usually grazed along with cattle. They are moved from one grazing area to another based on availability of pasture. Grazing starts at 10:00 am and continues all day. Usually the only form of supplementation is provision of minerals and salt licks. Watering is twice a day at streams. At about 6:00 pm animals are driven back to the kraals. This usually is open space, often fenced with thorny woods. Most nomadic

pastoralists have developed strategies to keep their animals healthy. They include among others the application of ethno-veterinary knowledge. They sometimes combined indigenous and conventional strategies. The commonest ailments in sheep according to pastoralists are bloat and diarrhoea. They are traditionally thought to be controlled using groundnut oil and powdered baobao leaves. Other ailments such as helminths infection, poisoning and gastric-impaction are treated using *Khaya senegalensis* (madaci) bark and leaves. Ecto-parasites are controlled using tobacco leaves and paraffin.

Table 1: Effect of breed on haematological parameters

Parameter	Overall	Balami	Yankasa	Uda	WAD	Level
No.	120	32	32	32	24	of sig.
			Means±S.E			
WBCs	21.21±1.22	28.82±8.85^{bc}	11.95±0.90^{ab}	31.43±8.12^{c}	9.79±0.65^{a}	*
RBCs	7.36±0.14	8.03±0.27^{b}	6.65±0.26^{a}	7.08±0.42^{ab}	7.81±0.49^{b}	*
HB	9.00±0.12	9.83±0.39^{b}	8.77±0.28^{a}	8.80±0.38^{a}	8.46±0.34^{a}	*
HTC	39.76±3.48	41.78±3.01	47.86±12.85	35.14±2.81	32.42±3.08	NS
MCV	47.09±1.11	42.00±2.38	50.73±3.88	50.82±3.82	44.03±3.84	NS
MCH	12.83±0.14	12.36±0.34	12.53±0.23	13.11±0.50	13.47±0.36	NS
MCHC	28.97±0.45	31.78±1.67^{bc}	24.65±1.71^{a}	27.77±1.10^{ab}	32.56±1.96^{c}	**
PLT	64.67±0.72	65.93±1.49	64.29±1.62	63.63±1.67	64.85±1.38	NS
LYM %	64.98±0.96	61.18±2.90^{a}	63.83±2.64^{a}	73.08±3.46^{b}	60.77±3.82^{a}	*
NTP	31.17±0.90	30.22±3.23^{a}	30.29±3.51^{a}	25.01±3.93^{a}	41.80±2.34^{b}	*
RCD	10.61±0.17	16.96±0.27^{bc}	15.98±0.43^{ab}	17.74±0.32^{c}	15.46±0.65^{a}	***

WBCs = White blood cells ($x10^3/\mu L$)
RBCs = Red blood cells ($x10^3/\mu L$)
HB = Haemoglobin (g/dl)
HTC = Haematocrit (%)
MCV = Mean corpuscular volume (Fl)
MCH = Mean corpuscluar heamoglobin (Pg)
MCHC = Mean corpuscular haemoglobin concentration (g/dl)
LYM = Lymphocyte (%)
PLT = Platelet ($x10^3/\mu L$)
NTP = Neutrophil ($x10^3/\mu L$)
RCD = Red cell distribution (Fl)
* = P<0.05
** = P<0.01
*** = P<0.001
NS = Non- Significant
abc = means with different superscripts on the same row differ significantly

Market Sheep Management

Sheep brought to the market that were not sold immediately are tethered in shades or open environment with feeders and drinkers. Depending on the market situation they may remained for up to 1-2 weeks with dealers. The sheep are fed mostly with hay, cereal bran, cowpea husk or mixture. Scanty health management is practised. In the events of an outbreak, sheep are slaughtered and sold at give-away prices.

Data Collection

Blood collection and analyses

Three millilitres of blood each was collected from 120 sheep (32 each of Yankasa, Balami and Ouda and, 24 WAD) for both dry and wet seasons using a hypodermic syringe through the jugular vein. For each sample, 3ml was dispensed into a bottle containing ethylene diamine tetra-acetic acid (EDTA) for haematology. The blood samples were immediately transported to the Heamatology Laboratory of Abubakar

Tafawa Balewa University Teaching Hospital.

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 [10].

Red Cell Distribution

The red cell distribution (RCD) was determined using the Sysmex haematology analyser. Coefficient of variation (CV) of RDW was used to calculate for RDW as:

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

Table 2: Effect of sex on haemotological parameters

Parameter	Overall	Female	Male	Level of Sig.
No.	120	62	58	
		Means±S.E		
WBCs	21.21±1.22	23.17±5.43	19.50±3.77	NS
RBCs	7.36±0.14	7.76±0.28[a]	7.02±0.23[b]	*
HB	9.00±0.12	9.31±0.28	8.72±0.23	NS
HTC	39.76±3.48	44.32±7.37	35.77±2.26	NS
MCV	47.09±1.11	48.08±2.41	46.22±2.60	NS
MCH	12.83±0.14	12.67±0.21	12.96±0.31	NS
MCHC	28.97±0.45	27.52±1.10	30.23±1.24	NS
PLT	64.67±0.72	66.03±1.27	63.47±0.94	NS
LYM %	64.98±0.96	67.85±2.18	62.47±2.37	NS
NTP	31.17±0.90	32.56±2.62	29.94±2.42	NS
RCD	10.61±0.17	17.30±0.25[a]	16.00±0.33[b]	*

WBCs = White Blood Cells ($x10^3$/µl)
RBCs = Red Blood Cells ($x10^3$/µl)
HB = Haemoglobin (g/dl)
HTC = Haematocrit (%)
MCV = Mean Corpuscular Volume (fL)
MCH = Mean Corpuscluar heamoglobin (Pg)
MCHC = Mean Corpuscular haemoglobin concentration (g/dl)
PLT = Platelet ($x10^3$/µl)
LYM (%) = Lymphocyte Percent
NTP = Neutrophil ($x10^3$/µl)
RCD = Red Cell distribution (Fl)
* = P<0.05
NS = Non- Significant
ab = means with different superscripts on the same row differ significantly

Haemoglobin concentration determination

Haemoglobin was determined using the cyan-methaemoglobin method [10]. Twenty four empty test tubes were assembled in a rack including an extra tube for blank. Five millilitres of cyanide was poured in to 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 (GSC International 4-30421). 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 [11]. Red and white blood cells count and Thin-blood smears techniques for differential count have been similarly determined according to standard procedures by [10; 11; 12].

Table 3: Effect of season on haematological parameters

Parameter	Overall	Dry Season	Rainy	Level of
No.	120	60	60	Sig.
		Means±S.E		
WBC	21.21±1.22	10.74±0.50^{b}	33.18±6.56^{a}	***
RBC	7.36±0.14	8.02±0.26^{a}	6.62±0.22^{b}	***
HB	9.00±0.12	9.68±0.26^{a}	8.22±0.20^{b}	***
HTC	39.76±3.48	42.98±6.52	36.08±2.36	NS
MCV	47.09±1.11	46.01±1.94	48.32±3.11	NS
MCH	12.83±0.14	12.47±0.20^{b}	13.23±0.33^{a}	*
MCHC	28.97±0.45	29.35±0.88	28.53±1.51	NS
PLT	64.67±0.72	64.54±1.15	64.80±1.05	NS
LYM %	64.98±0.96	69.99±2.06^{a}	59.26±2.40^{b}	***
NTP	31.17±0.90	24.47±2.27^{b}	38.81±2.41^{a}	***
RCD	10.61±0.17	16.75±0.28	16.45±0.34	NS

WBC = White Blood Cells ($x10^3$/µl)
RBC = Red Blood Cells ($x10^3$/µl)
HB = Haemoglobin (g/dl)
HTC = Haematocrit (%)
MCV = Mean Corpuscular Volume (Fl)
MCH = Mean Corpuscluar heamoglobin (Pg)
MCHC = Mean Corpuscular haemoglobin concentration (g/dl)
PLT = Platelet ($x10^3$/µl)
LYM (%) = Lymphocyte Percent
NTP = Neutrophil (%)
RCD = Red Cell distribution (Fl)
* = P<0.05
*** = p<0.001
NS = Non- Significant
ab = means with different superscripts on the same row differ significantly

Data Analysis

Data generated were subjected to analysis of variance (ANOVA) using the general linear model (GLM) procedure of SPSS, version 22 [13]. All two factors interactions were tested and only the significant ones were included in the final model. Significantly different means were compared using the Duncan Multple Range Test (DMRT). The model utilized for ANOVA was as follows:

$Y_{ijkln} = U + B_i + S_j + A_k + Sn_l + (BS)_{ij} + e_{ijklm}$

Y_{ijkl} = Observation on dependent variables
U = Common Mean
B_i = effect of i^{th} breed
S_j = effect of j^{th} sex
A_k = effect of k^{th} age
Sn_l = effect of l^{th} season
$(BS)_{ij}$ = interaction effect of i^{th} breed and j^{th} sex
e_{ijklm} = random error term

Results

Effect of breed on haematogical parameters

Averages of haematological parameters by breeds were as presented in Table 1. There was significant breed effect on white and red blood cells, heamoglobin, lymphocyte and neutrophil (P<0.05), mean corpuscular haemoglobin concentration (P<0.01) and red cell distribution (P<0.001). However, there was non-significant breed influence on haematocrit, mean corpuscular volume, mean corpuscular heamoglobin and platelet. Uda had the highest white blood cells (31.43 x 10^3 / µL), lymphocyte (73.08%) and red blood cells distribution (17.74 Fl) while the least 9.79 $x10^3$ / µL, 60.77 %, 4.49 % and 15.46 Fl respectively were observed in WAD. The WAD had the highest MCHC (32.56 g/dl) and NTP (41.80 $x10^3$ / µL) while the least values were

observed in Yankasa (24.65 g/dl) and Uda (25.01 g/dl) respectively. However, Balami had highest RBC and HB while the least were observed in Yankasa and WAD.

Table 4: Effect of age on haematological parameters

Parameter	Overall	Young	Adult	Level of
No.	120	58	62	Sig.
		Means±S.E		
WBC	21.21±1.22	19.78±3.98	22.65±5.10	NS
RBC	7.36±0.14	7.22±0.27	7.51±0.25	NS
HB	9.00±0.12	8.77±0.26	9.25±0.25	NS
HTC	39.76±3.48	40.33±2.21	39.18±6.98	NS
MCV	47.09±1.11	49.48±2.94	44.70±1.97	NS
MCH	12.83±0.14	12.39±0.23^{b}	13.26±0.30^{a}	*
MCHC	28.97±0.45	26.96±1.38^{a}	30.97±0.92^{b}	*
PLT	64.67±0.72	63.03±1.09^{b}	66.30±1.09^{a}	*
LYM %	64.98±0.96	63.41±2.06	66.55±2.84	NS
NTP	31.17±0.90	30.24±2.53	32.09±2.50	NS
RCD	10.61±0.17	16.99±0.21	16.22±0.40	NS

WBC = White Blood Cells (x10^3/µl)
RBC = Red Blood Cells (x10^3/µl)
HB = Haemoglobin (g/dl)
HTC = Haematocrit (%)
MCV = Mean Corpuscular Volume (Fl)
MCH = Mean Corpuscluar heamoglobin (Pg)
MCHC = Mean Corpuscular haemoglobin concentration (g/dl)
PLT = Platelet (x10^3/µl)
LYM (%) = Lymphocyte Percent
NTP = Neutrophil (%)
RCD = Red Cell distribution (Fl)
* = P<0.05
NS = Non- Significant
ab = means with different superscripts on the same row differ significantly

Effect of Sex on Heamatological Parameters

Average heamatological parameters by sex are presented in Table 2. The ANOVA revealed significant (P<0.05) effect of sex on RBC count and RCD. Females had higher RCB (7.76 x10^3/ µL) and RCD (17.30 Fl) than males. The effect of sex on the other haematological parameters however was not significant.

Effect of Season on Haematological Parameters

Average haematological parameters by season are presented in Table 3. Significant influence of season on MCH (P<0.05), WBC, HB, LYM and NTP (P<0.001) were observed. The RBC, HB and LYM were higher in dry than rainy season. However, the other haematological parameters were not significantly influenced by season.

Effect of Age on Hematological Parameters

The average haemotological parameters by age are shown in Table 4. There was significant age effect on MCH, MCHC and PLT (P<0.05) while WBCs, RBCs, HTC, MCV, LYM, NTP and RCD were not significantly influenced. Adults had higher MCH, MCHC, PLT and LYM values (13.26 Pg, 30.97 g/dl, 66.30 x10^3/µL and 24.84 x10^3/µL respectively).

Table 5: Average haematological parameters by breed x sex interaction

	WBC	HB	MCH	LYM%	NTP
Overall mean ±SE	21.21±1.22	8.99±0.12	12.83±0.14	65.39±1.38	31.96±1.40
Balami (F)	46.13±6.80^{a}	10.03±0.37^{a}	12.20±0.40^{b}	69.84±3.39^{b}	30.67±1.40^{b}
Balami (M)	11.51±6.80^{c}	9.63±0.37^{b}	12.53±0.40^{b}	52.53±3.39^{e}	29.78±1.40^{b}
Yankasa (F)	12.54±6.80^{c}	9.29±0.37^{b}	12.99±0.40^{ab}	63.70±3.39^{bc}	32.27±1.40^{b}
Yankasa (M)	11.37±6.80^{c}	8.25±0.37^{b}	12.06±0.40^{a}	63.97±3.39^{bc}	8.31±1.40^{d}
Ouda (F)	18.11±6.80^{b}	9.36±0.37^{b}	12.31±0.40^{b}	67.80±3.39^{b}	33.77±1.40^{b}
Ouda (M)	44.74±6.80^{a}	8.23±0.37^{bc}	13.91±0.40^{a}	78.36±3.39^{a}	16.25±1.40^{c}
WAD (F)	12.23±13.03^{c}	6.44±0.71^{c}	12.17±0.77^{b}	71.94±6.49^{b}	39.19±6.57^{a}
WAD (M)	10.36±6.80^{c}	8.76±0.37^{b}	13.36±0.40^{a}	55.01±3.39^{e}	45.44±1.40^{a}
Level of sig.	***	**	*	***	*

LYM (%) = Lymphocyte Percent
F = Female
NTP = Neutrophil (%)
WBC = White Blood Cells ($x10^3/\mu l$)
HB= Haemoglobin (g/dl)
MCH= Mean Corpuscular haemoglobin (Fl)
Se = Standard error
M = Male
** = $p<0.001$
* = $P<0.05$
*** = $p<0.001$
abc = means with different superscripts on the same column differ significantly

The effect of breed x sex interaction on haematological parameters

Table 5 depicts breed x sex interaction effect on the haematological parameters. There was significant breed x sex interaction effect on WBC, LYM % ($P<0.001$), HB ($P<0.01$), MCH and NTP ($P<0.05$). The Balami females and Ouda males had the highest

WBC values; 46.13 and 44.74 $x10^3$ /µL respectively, followed by Ouda females (18.11 x 10^3 /µL). The other categories however have similar value. For HB, Balami female had the highest value 10.3 g/dl, while WAD female had the least 6.44 g/dl. The other groups however have similar values. Higher values for MCH were recorded in Ouda male 13.91 Fl, followed by WAD male 13.36 Fl while values for the categories were comparable. Values for LYM % were however highest 78.36 in Ouda male, followed by 71.94, 69.84 and 67.80 % for WAD, Balami and Ouda females respectively. The least values were however recorded in Balami (52.53%) and WAD (55.01 %) males while values for the other categories were similar.

For NTP, the highest values recorded were 45.44 and 39.19 % in WAD male and female respectively while the least was recorded in Yankasa male (8.31 %).

Discussion

As already stated, haematological parameters are useful in the evaluation of the physiological and health status and, management of animals. Furthermore, they vary due to genetic and environmental causes [16]. Generally, the haematological parameters in this study are within the normal range.

Effect of breed on haematological parameters

The significant variation in RBC, WBC, HB, LYM, NP by breed observed in this present study is in agreement with the findings of [22]. The non-significant breed

influence on haematocrit, MCV, MCH and platelets on the other hand disagrees with the report by [15]. The higher WBC, RBC and LYM values in Ouda than other breeds has also been reported by [14]. The findings that WAD and Balami had higher MCHC and NTP and, RBC and HB respectively agree with the report by [16]. The differences between breeds may be due to intrinsic variations leading to physiological and hormonal deviations. This may further have effect on parameters.

Effect of sex on haematological parameters

In the present study, that RBC and RCD were affected by sex, being higher in females agree with [17]. This could be due to hormonal difference [16]. The non-significant variation in the other haematological parameters with sex agrees with [18] but disagrees agrees with [19].

Effect of season on haematological parameters

The report in this present study that MCH, WBC, RBC, HB, LYM and NTP were significantly affected by season has been similarly reported by [14]. The RBC, HB and LYM exhibited higher values in the dry than rainy season which is in accord with [20]. The seasonal variation might be due to high environmental temperature in dry than in wet season. This is similar to the report of [4] who reported that increase in environmental temperature cause an increase in haematological values.

Effect of age on haematological and biochemical parameters

The significant age influence on MCH, MCHC, platelets and LYM in this study and in favour of adult sheep agrees with findings of [21]. The higher values in MCH, MCHC, platelets and LYM observed in this study suggest a well-developed immune system in adult sheep than in young which has similarly been reported by [16] that immune system in sheep increases with age.

Average haematological parameters by breed x sex interaction

The observed higher values of WBCs, HB, NTP and LYM and lower MCH for female Balami than males agree with [11]. [17] however reported lower WBCs, HB, MCH and NTP values in Yankasa females than their male counterparts while the latter had lower lymphocytes. This contradicts the present study where higher values for WBCs, HB, MCH and NTP were recorded in female Yankasa than males. Similarly, males had higher lymphocytes. Female Ouda had higher values for HB, NTP only while WBCs and LYM were higher Ouda males. This is similar to the findings of [20] where some parameters namely WBCs, LYM, RBC and RCD were higher in males while others WBCs, HB, MCH and MCHC were higher in females. Female WAD also had higher values for HB, MCH and NTP than male has been observed by [22]. The probable explanation for mostly higher haematological parameters in females than males across breed could be due hormonal difference. That female hormone is usually associated with high metabolic activities resulting in higher values of haematological and biochemical parameters [23].

Conclusion and Applications

1. Most of the haematological parameters were mostly affected by breeds and season.
2. The haematological parameters were higher in Uda than the other breeds.
3. Rainy season exhibited higher haematological parameters than the dry and they were also influenced by age in favour of adult sheep.

4. It is better to assess blood parameter by sex within breed rather than by breed only.
5. There should be routine checks on haematological parameters as their values may be helpful in assessing the health status and general conditions of the animals.
6. More attention should be given to the animals in terms of nutrition to maintain normal haematological parameters values all year round.
7. Further studies should be carried out to include the effects of more environmental factors such as ambient temperature, altitude and relative humidity on haematological parameters.

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