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Analysis of genetic and non- genetic factors affecting haematology and biochemical parameters of Nigerian indigenous sheep

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***Target Audience:** Animal breeders, Farmers, Policy makers*

Abstract

The study evaluated the effect of genetic (breed) and non-genetic (sex, age) factors on hematological and serum biochemistry profile of indigenous sheep. A total of ninety four (94) sheep from four indigenous breeds of Nigerian sheep were obtained from Niger Delta region of Nigeria. These comprised of 30 West African Dwarf (WAD), 16 Uda, 8 Balami and 40 Yankasa. For haematological and serum parameters, breed, sex and age had influence on the indigenous sheep. The mean value for Uda breed was observed to be superior in PCV, Hb and RBC. However, WAD breed had highest values among the breeds for both MCV and MCH parameters while MCHC all had similar values recorded among the breeds. Furthermore, AST (Aspartate aminotransferase and ALT (Alanine aminotransferase) had superior values in Uda and Yankassa that had similar values respectively. Values for urea were within similar range for Uda and Balami and were ranked the highest among the breeds. Total protein was superior in WAD sheep and Balami were ranked highest in Mg. Furthermore, haematological profile and serum biochemistry profile were superior in male gender for PCV, Hb, RBC, Neutrophil, Eosinophil, total protein, calcium, phosphorus and Alkaline phosphatase. The mean value at age 4 had highest mean value for PCV, Hb, RBC, platelet, Alkaline phosphatase and Alanine aminotransferase respectively, while calcium was ranked the highest at age 6 years. WBC recorded highest value for Uda breed at age 2 while superior value for platelet was recorded for WAD at age 6. Neutrophil also recorded value with similar range among Uda at age 4, Uda at age 2 and Balami at age 6 years which were ranked superior among the interaction effect. The mean value for lymphocyte was highest in Balami and Uda at age 6 respectively while Balami at age 4 was ranked highest for eosinophil. Mg and Phosphorus were ranked highest in Uda at age 2 while Yankassa was highest in albumin. However, total protein was highest in WAD at age 4 while creatinine was highest for Balami at age 6 and Uda at age 2. Balami at age 2 had superior mean value for urea while WAD at age 2 was highest for calcium. Uda breed of sheep at age 4 had the highest value for ALT and AST parameters respectively. This further stipulated that breed, sex and age had influence on indigenous sheep and thus, deliberate effort should be put in place to ameliorate the changes.

***Key words:** Haematology, Breed, Age, Indigenous sheep, Biochemical*

Description of problem

The goal of every livestock farmer is to ensure efficient and sustainable production of its products but in Nigeria, they are hampered by series of constraints which has hindered such target (1). Similar to other developing countries, feed availability remains a major concern due to shortage of grazing areas, scarcity of good quality feed resources, limited property rights , high cost

of concentrated feed , non-availability of supplemented feed and fodders ,shortage of water and poor quality water (2). However, gender and experience in the production and availability of grazing ground also has a significant effect in decisions on herd size, wool, and milk production (3). The management of sheep is still largely in traditional hands and its potentials has not been fully utilized, since most of them does not have access to improved species and thus, kept in dilapidated houses making them susceptible to infectious diseases and predators (4). Productivity will be at maximum if knowledge of the haematological profile and serum biochemistry of animal is of relevance in diagnosis of serious diseases which can lead to financial losses in livestock production. The objective of this research was to assess the effect of breed, sex and age on the hematological profile and serum biochemistry profile in indigenous sheep.

Materials and methods

Experimental location and population of experimental animals

The research was done in Rivers State, Port Harcourt, Nigeria which lies between latitude 4^{o}N and longitude 7^{o}E. A total of ninety four (94) sheep from four indigenous breeds of Nigerian sheep were obtained from different locations of southern part of Nigeria. These comprised of 30 West African Dwarf, 16 Uda, 8 Balami and 40 Yankasa. The age of animals used was determined through dentition. Teeth numbers, in combination with dental eruption and wearing pattern was used to determine the age of sheep according to the procedures of (28, 29 and 30). Three age groups of sheep were identified in the study area - 2, 4 and 6 years with 21, 33 and 40 animals respectively.

Blood collection, haematology and serum biochemical analysis

Blood samples (10ml) were collected from the jugular vein of each animal from Trans-Amadi abattoir, Mile 3 and Rumuodomaya abattoirs, Port Harcourt, Rivers state, into two bottles. One portion was collected into vacutainer tubes without EDTA. The second portion of blood sample was convened into EDTA bottles for haematological analysis. The blood sample were analyzed for red blood cell (RBC), packed cell volume (PCV), haemoglobin (Hb), white blood cell (WBC), platelets, neutrophil, eosinophil, monocyte, mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration using automatic haematology analyzer (CELL-DYN 3700 Abbott, USA). While for serum, samples were kept in a separator at 3000 rpm for 10 minutes for serum to be extracted, stored at $-20^{\circ}C$ prior to further analysis for Total protein, Albumin (ALB), Cholesterol, Urea, Creatinine (CR), Calcium, Phosphorus, Aspartate aminotransferase (AST) and Magnesium was carried out using an automated analyser. Thus, Alanine aminotransferase (ALT) and alkaline phosphatise (ALP) were analysed using spectrophotometric linked reaction method (21).

Statistical analysis

Data obtained from laboratory analysis were examined using the General Linear Model of Statistical Analysis System (22). Turkey multiple range test was used to separate the treatment means at ($P<0.05$). The linear model considered only the interaction between age and breed of sheep in this study. All other two ways and three ways interactions were not significant.

Table 1: Effect of breed on hematological parameter of sheep

Breed	PCV (%)	Hb (g/dl)	RBC (10^6/ul)	WBC (10^3/ul)	Platelet (10^3)	Neu (%)	Lym (%)	Eos (%)	Mon (%)	MCV (fl)	MCHC (g/dl)	MCH (pg)
BALAMI	23.50±1.42^{c}	7.83±0.4^{c}	3.56±23^{c}	7.45±1.01	201.42±14.42	22.71±1.90	67.14±2.07	3.14±0.39	7.02±0.97	65.86±1.12^{b}	33.33±0.16	21.95±0.38^{b}
UDA	30.90±1.47^{a}	10.30±0.5^{a}	4.66±0.24^{a}	7.30±1.05	213.30±14.91	27.47±1.96	64.47±2.14	2.47±0.40	5.60±1.01	6681±1.16^{b}	33.34±0.16	222.7±0.39^{b}
WAD	25.57±1.05^{b}	8.53±0.35^{b}	3.61±0.17^{c}	7.21±0.75	222.61±10.61	26.86±1.40	65.24±1.52	2.65±0.28	5.25±0.72	71.29±0.83^{a}	33.34±0.11	23.77±0.28^{a}
YANKASA	27.33±1.04^{b}	9.12±0.35^{b}	4.15±0.17^{b}	7.17±0.74	215.06±10.54	26.54±1.39	63.28±1.51	3.08±0.28	7.09±0.71	66.07±0.82^{b}	33.37±0.11	22.05±0.28^{b}

^{ab} Means within column bearing distinct characters differ significantly (P<0.05)
PCV (Packed Cell Volume), Hb (Haemoglobin), RBC (Red Blood Cell), WBC (White Blood Cell), Platelet, Neu (Neutrophil), Lym (Lymphocyte), Eos (Eosinophil), Mon (Monocyte) MCV (Mean Corpuscular Volume), MCHC (Mean Corpuscular Haemoglobin Concentration), MCH (Mean Corpuscular Haemoglobin) R-V (Reference Value).

Table 2: Effect of Breed on Serum Biochemistry Profile in the Nigerian Indigenous Sheep Breeds

BREED	AST (u/l)	ALT (u/l)	ALP (u/l)	Ca (mm/l)	UR (mm/l)	CR (mm/l)	TC (mm/l)	TP (g/l)	ALB (g/l)	Mag (mg/dl)	Phos (mg/dl)
WAD	126.73±7.71^{ab}	33.40±3.38^{a}	7.15±0.45	6.93±0.54	4.27±0.33^{b}	180.07±0.56^{b}	2.09±0.12	70.47±0.82^{a}	30.13±1.09^{ab}	2.44±0.09^{c}	6.57±0.39
YANKASA	147.15±6.04^{a}	40.20±2.56^{a}	7.83±0.31	7.05±0.23	5.61±0.42^{ab}	180.15±0.47^{b}	2.09±0.07	64.50±1.07^{b}	32.45±2.08^{a}	2.86±0.24^{bc}	6.67±0.32
UDA	153.88±15.17^{a}	36.00±5.06^{a}	7.39±0.20	7.73±0.44	6.61±0.60^{a}	184.13±1.16^{a}	2.35±0.16	65.13±2.15^{b}	24.50±1.59^{c}	3.29±0.53^{b}	7.43±0.53
BALAMI	107.00±1.73^{b}	19.25±1.93^{b}	7.80±0.99	6.85±0.91	6.83±1.27^{a}	186.00±2.61^{a}	2.28±0.19	65.00±1.83^{b}	26.5±4.09^{bc}	4.15±0.57^{a}	6.23±0.79
RV	60–280	26–34	68–387	11.8–12.8	2.8–7.1	106–168	1.35-1.97	60–79	24-30	2.2–2.8	5.0 -7.3

^{a,b,c} Means in the same column with distinct characters differ significantly(p<0.05). AST- Aspartate aminotransferase, ALT- Alanine aminotransferase, ALP- Alkaline phosphatase, CA- Calcium, UR- Urea, TP- Total protein, ALB- Albumin, Mag- Magnesium, Phos- Phosphorus, TC- Total cholesterol, CR- Creatinine and RV- Reference

$Y_{ijkl} = \mu + B_i + A_j + S_k + (AB)_{ij} + E_{ijkl}$
Where;
Y_{ijkl} = the effect of biochemical parameters in Nigerian sheep
μ = population mean
A_i = effect of i^{th} age (i= 1…….n)
B_j = effect of j^{th} breed (j= Balami, Yankasa, Uda, West African Dwarf)
S_k = effect of k^{th} sex (k= Male, Female)
$(AB)_{ij}$ = interaction effect of age and breed of sheep $(AS)_{ik}$
E_{ijkl} = error term

Results and Discussion

Effect of breed on haematological profile and serum biochemistry profile in sheep

Table 1 shows the effect of breed on the hematological profile in the Nigerian indigenous breeds of sheep. The result revealed significant (P<0.05) difference in PCV (packed cell volume), Hb (hemoglobin), and RBC (red blood cell). However, PCV value for Uda was superior among the breeds. The average value for Hb had mean value difference of 2.47% between Uda (highest value) and Balami (lowest value). RBC had comparable values between Balami and WAD but was significantly lower than Uda and Yankasa. The mean value for MCV (mean corpuscular volume) had values that were statistically highest for the WAD breed, when compared to the rest. Yankasa and Uda had values for PCV and Hb fall within the normal reference range approved by (5) which is an indication for healthy breeds of sheep and thus, suggested that diets seem more capable of supporting high oxygen carrying capacity and nutrient absorption, while Balami and WAD had values below the normal range, which implies that the breeds did not adapt to the diet. The higher the concentration of PCV and Hb, the higher the oxygen carrying capacity which in turns makes the breed more resistance to infectious disease as agreed by(6 and 7). The red blood cell reported in this study within the range for the breeds were lower than the values of 8.93-10.81 (10^6/ul) reported by (8) for hematological profile for indigenous sheep. A decline in the quantity of red blood cell count recorded for the breeds is an indication that they are iron deficient which is a major precursor to anemia related disease condition. This also leads to decline in the amount of oxygen transported to the tissues as well as the level of carbon dioxide conveyed back to the lungs which were collaborated by (7). Furthermore, MCV had values among the breeds fall below the reference range 102.02-112.40 reported by (8). This highlighted that lower range of MCV is an indication of microcytic anemia which occurs as a result of poor dietary intake of iron as confirmed by (27). MCHC also had values below the range observed by (8). This marked the presence of anemia which was as a result of decline of red blood cell in the level of hemoglobin as agreed by (27). Values for MCH among the breeds had values below the range recorded by (8). This suggested that low level of MCH could be attributed to genetic condition referred to as thalassemia which was related to limited production of hemoglobin as in agreement with (27) theory.

Table 2 shows the effect of breed on serum biochemistry profile in the Nigerian indigenous sheep. AST was significantly different (P< 0.05) with superior values recorded in the Uda ranked the highest mean values while the lowest mean value was observed in Balami breed. The mean values for ALT, ALP, Calcium, TC (total cholesterol) and phosphorus had no significant (P<0.05) difference across the breeds. CR (creatinine) had significant difference (P<0.05) as it also increases within the various breeds with Balami ranked the highest mean value. TP (total

protein) had significant different (P<0.05) as with a statistical mean value difference of 5.97g/l between WAD and Balami. However, ALB was significantly different (P<0.05) with Yankasa superior among the breeds. Magnesium had significant different (P<0.05) within the various breeds of sheep as it increases within the breeds from West Africa dwarf, Yankasa, Uda and then Balami with the highest mean value. The higher values observed in creatinine may be attributed to renal functional impairment, which causes intrinsic renal lesions and decreased perfusion of the kidney. It has been reported that Creatinine varied with seasonal variation (9). In Yankasa breed, the higher value of Albumin from the study was also in agreement with (10) who also recorded higher values. Increased Albumin levels have been related to seasonal variation (9). From the normal range standard in Magnesium, Yankasa breed had statistical different of 0.06mg/dl while Uda and Balami breed recorded higher values. According to (10), higher mean values was recorded in Uda, Yankasa and Balami breeds with statistical different of 0.09mg/dl in WAD sheep breed. Calcium, Total cholesterol, Phosphorous, ALT and ALP had no significantly different (P<0.05) on the breeds of sheep indigenous to Nigeria. Total cholesterol had higher values in this study and according to (11) TC values vary with reproductive status of the animal. Calcium and Phosphorous recorded higher values in this study as it is caused by nutritional factors. According to (12) ALT was within the normal range value of 12.0-57.0 u/l.

Table 3: Effect of sex on hematological parameters of sheep

Parameters	Male	Female	R-V
PCV (%)	27.58±1.32[a]	26.55±0.67[b]	27-45
Hb (g/dl)	9.18±0.45[a]	8.86±1.32[b]	8-16
RBC (10^6/µl)	4.10±0.22[a]	3.97±0.11[b]	9-15
WBC (10^3/ul)	7.88±0.94	7.00±0.48	4-12
Platelet (10^9)	200.40±13.42	218.96±6.83	100-500
Neutrophil (%)	26.59±1.76[a]	25.66±0.90[b]	2-9
Lymphocyte (%)	64.08±1.93[b]	65.26±0.98[a]	2-9
Eosinophil (%)	3.05±0.40[a]	2.77±0.18[b]	0-1
Monocyte (%)	6.29±0.91	6.31±0.46	0-0.75
MCV (fl)	67.37±1.05	67.41±0.53	102.02-112.40
MVHC (g/dl)	33.30±0.14	33.37±0.07	35.07-37.23
MCH (pg)	22.43±0.36	22.49±0.18	30.4-32.65

a, b Means across the row bearing distinct characters differ significantly (P<0.05)
PCV (packed cell volume), WBC (white blood cell), platelet, Neu (neutrophil), Lym (lymphocyte), Eos (eosinophil), Mon (monocyte), MCV (mean corpuscular volume) ,MCHC (mean corpuscular hemoglobin concentration) , MCH(mean corpuscular hemoglobin) R-V (Reference value)

Effect of sex on haematological profile and serum biochemistry profile in sheep

Table 3 shows the effect of sex on the hematological profile in the Nigerian indigenous breed of sheep. The PCV was significantly different (P<0.05) across the row with a difference of 1.03% volume between male and female sheep. Hb was also significantly different (P<0.05) across the row with the male gender superior to the female gender. The value for RBC was significantly different (P<0.05) across the row with the male gender observed to be slightly higher than the female gender. Neutrophil was significantly different (P<0.05) across the row with the female

gender lower than the male gender. The mean value for lymphocyte was also significantly different (P<0.05) across the row with the female gender superior to the male gender. Eosinophil was also significantly different (P<0.05) across the row with a statistical mean value difference of 0.28% volume between the male and female gender. The higher range of hematological parameters superior in males more than the female gender is attributed to testosterone in males, which stimulates the production of erythropoiesis compared to estrogen that inhibits the production of erythropoiesis as agreed by (13). This also implies that the male gender had better immune response against disease condition more than the female gender as confirmed by (14). However, it can be concluded that sex had an influence in the hematology of animals. Furthermore, MCV, MCHC and MCH all had values below the range identified by (8) report. This may be attributed to anemia and thalassemia which was associated to genetic condition.

Table 4 shows the effect of sex on the serum biochemistry profile in the Nigerian indigenous sheep breeds. AST showed no different in the sex of the sheep although the female was slightly higher than the male with a value of 0.47u/l. ALT had no significant different (P<0.05) as higher mean values were observed in the male more than the female gender. ALP showed significant difference (P<0.05) the higher mean value was superior in the female gender as more than the male. Calcium showed significant difference (P< 0.05) on the sex of sheep, the mean value was slightly higher in the female compared to the male with a value of 1.87mm/l. Urea showed no significant difference (P>0.05) as the male sheep had the higher mean value with the lower value observed in the female sheep. Creatinine showed no significant difference (P>0.05) in the sex of the sheep although the mean value recorded in the male gender is superior to the female. TC showed no significant different (P>0.05), the higher mean values to female sheep and lowest mean values to the male sheep with a value of 0.2mm/l. The sex of sheep had no influence on TP but the mean value for males was 0.23g/l higher than that of their female counterpart. However, albumin was significantly different (P<0.05) as the higher mean value was higher in both male and female. Magnesium had no significant difference (P>0.05) in both genders. Phosphorous showed significantly higher (P<0.05) as the female sheep had the superior mean value more than the male sheep. Lower values of ALT obtained in male and female sheep from the study was in tandem with those reported by (15). The values recorded for Calcium was within the reference range reported by (16). Albumin for female was within the reference range but slightly above the value for male which was in accordance with (16), who had similar value in male and female sheep, and that variation are expected from animals in different geographical and ecological location. Creatinine recorded for both sexes had increased values as variations may be linked with seasonality (9).

Table 4: Effect of Sex on Serum Biochemistry Profile of Nigerian Indigenous Sheep Breeds.

SEX	AST (u/l)	ALT (u/l)	ALP (u/l)	Ca (mm/l)	UR (mm/l)	CR (mm/l)	TC (mm/l)	TP (g/l)	ALB (g/l)	Mag (mg/dl)	Phos (mg/dl)
MALE	138.00±9.91	38.18±3.95	6.89±0.41[b]	5.67±0.29[b]	5.60±0.91	181.73±1.24	1.99±0.12	66.73±1.38	36.91±2.76[a]	2.65±0.31	5.93±0.42[b]
FEMALE	138.47±5.49	34.72±2.20	7.73±0.24[a]	7.54±0.24[a]	5.41±0.25	181.17±0.50	2.19±0.06	66.50±1.89	27.69±0.93[b]	2.98±0.18	6.97±0.23[a]
RV	60 – 280	26 – 34	68 – 387	11.8 – 12.8	2.8 – 7.1	106 – 168	1.35-1.97	60 – 79	24 - 30	2.2 – 2.8	5.0 -7.3

a,b,c Means in the same column with distinct characters differ significantly(p?0.05) AST-Aspartate aminotransferase, ALT-Alanine aminotransferase, ALP-Alkaline phosphatase, CA-Calcium, UR-Urea, TP-Total protein, ALB-Albumin, Mag-Phosphorus, TC-Total cholesterol ,CR-Creatinine and RV-Reference value Magnesium, Phos-Phosphorus, TC-Total cholesterol ,CR-Creatinine and RV-Reference value

Effect of age on blood parameters in Nigerian indigenous sheep

Table 5 shows that PCV, Hb, RBC, platelets were all significantly different (P<0.05) across the age range. The mean value for PCV was significantly different (P<0.05) across the row with ages 4 superior than age 2 and 6 with similar range respectively. Mean value of Hb was also significantly different (P<0.05) across the rows with a statistical mean value difference of 0.26g/dl between age 4 ranked the highest and age 2 ranked as the lowest. RBC was significantly different (P<0.05) across the rows with similar values recorded in age 2 and 6 but lower than age 4. However, platelet was also significantly different (P<0.05) within the rows with a statistical difference of 25.42(10^9/l) between age 4 observed as the highest and age 2 ranked as the lowest. Furthermore, there was no significant difference (P>0.05) observed for MCH, MCV and MCHC parameters. Age 4 had values for PCV and Hb within the reference range, which suggested that they are healthy and thus adjusted favorably to the requirement of the diet, as well as the study area of the habitat. However, age 2 and 4 had values fall below the reference range which is an indication of poor condition to suitably adjust to the diet and the study area of the habitat. This was in agreement with (6 and 7), which concluded that the higher the PCV and Hb, the higher the oxygen carrying capacity, as well as efficient nutrient absorption. The mean value for RBC with respect to the age range falls below the reference value which was in agreement with (8) which concluded that such RBC count is an indication that they are iron deficient which is a major precursor to anemia related disease conditions. This will result to a decline in the level of $C0_2$ that will be conveyed back to the lungs as reported by (7). Furthermore, values for platelet, with respect to age variations fall within the reference range which was collaborated by (8), who affirmed that normal platelet range indicates proper maintenance of homeostasis, and thus possess the tendency to initiate clothing, so as to stop excessively bleeding in case of injury. However, mean values for MCH among the age variations all had values below the range identified by (8) report. This could be attributed to limited production of hemoglobin in the blood as supported by (27) observations. Thus, MCV among the age variations all had values below the range identified by (8). This could be attributed to the lack of poor dietary intake of iron which is a major precursor to anemia as supported by (27) observations. Mean values obtained for MCHC were lower than those reported by (8). This may be contributed to limited production of hemoglobin which was a major attribute to genetic condition called thalassemia, as in agreement with (27).

Table 6 represents the effect of age on the serum biochemistry profile in the Nigerian indigenous sheep breeds. AST was significantly different (P< 0.05) across the ages with age 2 and 4 higher than age 6. Also, Serum ALT were similar in ages 2 and 4 but significantly higher (P <0.05) than mean value recorded for age 6. Alkaline phosphate (ALP) showed significant difference (P<0.05) across the ages with age 6 showing mean value higher than age 2 and 4. Calcium level showed significant difference (P< 0.05) across the ages. Calcium is increasing as the ages increases. Albumin was significantly different (P<0.05) as it decreased in age 4 and 6 with 9.34g/l statistical different. Phosphorous showed significant different (P<0.05) as it increases as the age increases. AST and Phosphorous were within the reference values. The ALP reported in this study was below the normal range in the reference value. Similar value in

ALP was reported in the work of (17). The mean value for Calcium reported from the study was in agreement with those reported by (10) both of which were above than the reference range. The high calcium level in the blood (hypocalcaemia) of indigenous sheep could lead to weakness of the bones and interference with normal functioning of the kidney (18). The average value of ALT was higher than the normal. This result corroborates the report of (19) that had higher values in *T. gondii* positive and *T. gondii* negative sheep. Total cholesterol value in this work was above the range value but in agreement with the research work of (12) who also reported similar result for total cholesterol. Creatinine level report in this research work was above the normal range value. The high level of creatinine reported may be attributed to dehydration related to seasonal variation caused by fluid loss (9). Variation in the values of Magnesium with respect to age range was in agreement to (10) findings. It has earlier been reported that magnesium is required for proper calcium absorption as a result, no calcium intake can occur without magnesium intake (20).

Table 5: Effect of age on hematological parameters of sheep

	Age (Years)			
Parameters	**2**	**4**	**6**	**R-V**
Number of animals	21	33	40	
PCV (%)	26.06±1.26^{ab}	28.56±0.81^{a}	26.18±0.96^{b}	27-45
Hb (g/dl)	8.69±0.42^{ab}	9.52±0.27^{a}	8.74±0.32^{b}	8-16
RBC (10^6/µl)	3.88±0.21^{b}	4.34±0.13^{a}	3.84±0.16^{b}	9-15
WBC (10^3µl)	7.21±0.90	7.19±0.58	7.36±0.68	4-12
Platelet (10^9/l)	199.32±12.74^{b}	224.74±8.24^{a}	219.17±9.74^{ab}	100-500
Neutrophil (%)	26.27±1.67	25.00±1.08	26.48±9.74	2-9
Lymphocyte (%)	64.26±1.83	64.81±1.18	65.78±1.40	2-9
Eosinophil (%)	3.04±0.34	3.17±0.22	2.30±0.26	0-1
Monocyte (%)	6.43±0.86	7.02±0.56	5.44±0.66	0-0.75
MCV (fl)	67.23±0.99	66.12±0.64	68.89±0.76	102.02-112.40
MCHC (g/dl)	33.34±0.14	33.31±0.09	33.37±0.11	35.07-37.23
MCH (pg)	22.41±0.33	22.04±0.22	22.99±0.26	30.4-32.65

^{a,b} Means in the same with distinct characters differ significantly (P<0.05). PCV (Packed Cell Volume), Hb (Haemoglobin), RBC (Red Blood Cell), WBC (White Blood Cell), Platelet, Neu (Neutrophil), Lym (Lymphocyte),Eos (Eosinophil),Mon (Monocyte) MCV (Mean Corpuscular Volume) ,MCHC (Mean Corpuscular Haemoglobin Concentration) , MCH(Mean Corpuscular Haemoglobin) R-V (Reference Value).

Table 6: Effect of Age on Serum Biochemistry Profile in the Nigerian Indigenous Sheep Breeds

AGE (Years)	AST (U/L)	ALT (U/L)	ALP (U/L)	Ca (mmol/l)	UR (mmol/l)	CR (mmol/l)	TC (mmol/l)	TP (g/l)	ALB (g/l)	Mag (mg/dl)	Phos (mg/dl)
2	135.17±9.48^{ab}	37.00±3.79^{a}	7.05±0.41^{b}	6.10±0.50^{b}	5.47±0.84	181.33±1.19	2.03±0.12	66.33±1.32	36.42±2.57^{a}	2.61±0.29	5.93±0.39^{b}
4	146.16±5.63^{a}	37.04±2.03^{a}	7.42±0.25^{b}	7.22±0.25^{a}	5.39±0.24	181.28±0.57	2.22±0.08	67.68±1.09	27.08±1.03^{b}	3.00±0.22	6.91±0.29^{ab}
6	122.70±12.35^{b}	30.00±5.93^{b}	8.40±0.51^{a}	8.02±0.43^{a}	5.60±0.71	181.30±1.16	2.12±0.09	64.00±1.35	28.90±2.18^{b}	3.03±0.35	7.24±1.43^{a}
RV	60 – 280	26 – 34	68 – 387	11.8 – 12.8	2.8 – 7.1	106 – 168	1.35 -1.97	60 – 79	24 – 30	2.2 – 2.8	5.0 -7.3

^{a,b,c} Means in the same column with distinct characters differ significantly (P<0.05). AST- Aspartate aminotransferase, ALT-Alanine aminotransferase, ALP- Alkaline phosphatase, CA- Calcium, UR- Urea, TP- Total protein, ALB-Albumin, Mag-Magnesium, Phos-Phosphorus, TC- Total cholesterol, CR- Creatinine, RV – Reference Values

Interaction effect of breed and age on blood profile biochemical parameter in sheep

Table 7 shows the following observation on breed and age interaction effect. PCV had a mean value ranked highest for Uda breed of sheep at age 4 among the breed and age interactions. Hb value had superior value recorded for Uda breed of sheep at age 4 while the lowest mean value was observed in both WAD at age 6 and Balami at age 4 that recorded similar values among the interaction. The mean value for RBC had a statistical mean value of 2.44% volume between Uda breed of sheep at age 4 (highest value) and WAD breed of sheep at age 6. WBC value was highest for Uda breed at age 2 among the interaction effect. Mean value for platelet was ranked highest at WAD breed of sheep at age 6. Neutrophil also recorded value with similar range among Uda at age 4, Uda at age 2 and Balami at age 6 which were ranked superior among the interaction effect. However, the mean value for lymphocyte were superior for Balami breed at age 6 and Uda breed at age 6 among the breed and age interactions. Eosinophil had value recorded the lowest for Uda breed of sheep at age 6 while the highest value was recorded for Balami breed of sheep at age 4. However, mean values for MCV, The mean value for monocyte had a mean difference of 4.78% volume recorded between Yankasa breed of sheep at age 4 (highest value) and Uda breed of sheep at age 6 (lowest value). Balami breed of sheep at age 2, 4, 6, Yankasa at age 4 and WAD at age 6 all had values fall below the reference range as corroborated by (5). This may be attributed to low adaptability of the animals to their diet thereby leading to decline in nutrient absorption as the aged. The mean value for Hb had value for WAD breed of sheep at age 6 falls below the reference range as agreed by (6 and 7). This suggested that they encountered decline in transportation of oxygen, thereby making them more susceptible to infection. RBC value among breed and age interaction all had values fall below the values of 8.93-10.81 (10^6/ul) reported by (8) for hematological profile for indigenous sheep. The low red blood cell count recorded for the breeds is an indication that they are iron deficient making them susceptible to anemia related disease condition. WBC had values among the interaction effect within the reference range as agreed by (14). This stipulated that they are all capable of producing antibodies to withstand infection. The mean value for platelets all had values fall within the reference range among breed and age interactions as agreed by (8). This indicated that they had the tendency to initiate clothing so as to stop excessive bleeding in case of injury. High level of neutrophil above the reference range is an indication of pyogenic and parasitic infections as reported by (23). However, the mean value for lymphocyte above the reference range may be attributed to normal body response to an infection or inflammatory condition as reported by (24). Uda breed at age 6 had value within the reference range which indicates proper immune functioning while those above the normal range is an indication of parasitic infection as agreed by (23). Thus, interaction effect between breed and age all had values fall above the reference range which is a signal to inflammatory or parasitic infection as reported by (23). Furthermore, MCV, MCHC and MCH all had values below the range identified by (8) report. This may be attributed to anemia and thalassemia which was associated to genetic condition.

Interaction Effect of Breed and Age on Serum Biochemistry Profile

Table 8 shows the interaction between the effects of breed and age on the serum

biochemistry profile in the Nigerian indigenous sheep breeds. The following observation was made of the table below: AST the Uda breed of sheep, age 4 had the highest mean values and the lowest mean value was seen in Uda breed, age 6 with statistical different of 89.9u/l. ALT had highest mean values in the Uda sheep breed, age 4. ALP in Yankasa breed, age 6 had the highest mean value and the lowest mean values to Balami breed, age 6 with statistical different of 4.66u/l. However, lowest values for calcium were recorded in age 2 for WAD breed of sheep, Urea was seen to have its highest value in Balami sheep breed, age 2 with lowest value recorded in WAD sheep breed, age 2. Thus, creatinine had superior mean values in Balami, age 6 and Uda, age 2. Total cholesterol, had statistical different from Balami age 2 and Uda age 2 is 1.30mg/dl. However, Albumin had the highest mean value in Yankasa breed of sheep, at age 2. Magnesium had superior values in Uda breeds of sheep at age 2 with respect to other interactions. Phosphorous across the breeds and ages of sheep had the highest mean values in Uda, age 2, with the lowest in Balami, at age 6. AST had values within the reference range among the breed and age interactions which depicts normal functioning, and thus an absence of disease. This was in agreement with (25) report and thus supported by (26) findings which concluded that AST levels increase when there is damage to the tissues and cells where the enzyme is found. Variation of mean values among breed and age interaction for ALT was supported by (25) which concluded that such may occurs due to instability to immune response. The decrease level of ALP value among breed and age interaction may be related to (hyperadrenocorticism) as agreed by (25). However, low level of calcium recorded in the study may be associated to malfunction of the parathyroid glands which produce a hormone (PTH) that controls blood calcium levels. This is in agreement with (25) report. Variation on the value of urea observed in the study may be attributed to kidney or liver disease as supported by (25). An elevation of creatinine from the interaction effect was as attributed to kidney disease or dehydration as reported by (25). Variation noticed for total cholesterol may be due to hypothyroidism or accumulation of fatty deposit within the artery, which was in strengthened by (25). Total protein can be elevated or decreased if the domestic animal is dehydrated or if the immune system is influenced to produce higher volume of antigen. This was observed from the study which was also confirmed by (25.) The interaction effect among breeds and age shows a variation for albumin which was in agreement with those reported by (25). When blood albumin experience decline, the pressure exerted by the heart forcing flow of blood via the blood vessel results, to fluid leakage out of the blood vessels and accumulate in body cavities such as the abdominal tissues as edema. Albumin is decreased due to liver damaged and cannot produce an adequate volume of albumin or kidney disease may initiate the loss of albumin via the intestine. According to (25), values recorded for magnesium was within reference range which indicated the sheep has the tendency to excrete excess magnesium in the urine and stool. Values obtained from breed of Uda at age 4, 2 WAD at 4, 6, and Yankasa 2 and 4 indicated that they are capable of performing metabolic and physiological functions efficiently.

Table 7: Interaction effect of Breed and Age on Hematological Profile of indigenous Sheep

Breed/age (yrs)	PCV (g/dl)	Hb (%)	RBC (10^6/µl)	WBC (10^3µl)	Platelet (10^9/l)	Neutrophil (%)	Lymphocyte (%)	Eosinophil (%)	Monocyte (%)	MCV (fl)	MCHC (g/dl)	MCH (pg)
Balami 2	24.00±3.28	8.00±1.14	3.60±0.56	7.50±2.41	187.00±34.30	22.00±4.51	68.00±4.93	3.00±0.92	7.00±2.32	66.67±2.67	33.33±0.37	22.22±0.91
Balami 4	22.50±2.38	7.50±0.81	3.45±0.39	7.00±1.70	196.00±24.25	15.50±3.19	58.40±2.20	3.50±0.65	7.50±1.64	65.03±1.89	33.35±0.26	21.69±0.64
Balami 6	24.00±1.02	8.00±0.34	3.64±0.17	7.86±0.73	221.00±10.34	30.64±1.36	75.00±3.48	2.91±0.28	6.55±0.70	65.91±0.81	33.30±0.22	21.95±0.90
Uda 2	31.00±3.38	10.30±1.14	4.70±0.56	9.50±2.41	215.00±34.30	30.00±4.51	60.00±4.93	3.00±0.92	7.00±2.32	65.96±2.67	33.32±0.37	21.92±0.91
Uda 4	34.20±1.51	11.40±0.51	5.34±0.50	6.54±1.08	241.40±15.34	31.40±2.02	58.40±2.20	3.40±0.41	6.80±1.04	64.91±1.20	33.33±0.16	21.63±0.41
Uda 6	27.50±2.39	9.20±0.81	3.95±0.93	5.85±1.70	183.50±24.25	21.00±3.19	75.00±3.48	1.00±0.65	3.00±1.64	69.58±1.89	33.46±0.26	23.28±0.64
WAD 2	26.50±1.69	8.83±0.57	3.78±0.28	6.18±1.20	185.00±17.15	24.75±2.47	67.50±2.46	3.00±0.46	4.75±1.16	69.99±1.34	33.31±0.18	23.31±0.45
WAD 4	28.22±1.13	9.40±0.38	4.16±0.19	8.34±0.80	219.33±11.43	27.33±1.50	64.22±1.64	2.44±0.13	6.00±0.77	68.03±0.89	33.31±0.12	22.66±0.30
WAD 6	22.00±2.39	7.35±0.81	2.90±0.39	7.10±1.70	263.50±24.25	28.50±3.19	64.00±3.48	2.50±0.65	5.00±1.64	75.83±1.89	33.41±0.26	25.33±0.64
Yankasa 2	24.40±1.85	8.15±0.63	3.66±0.30	6.58±1.32	204.80±18.79	27.30±2.47	62.90±2.70	3.10±0.50	6.70±1.27	66.67±1.46	23.31±0.45	22.31±0.50
Yankasa 4	29.33±1.13	9.78±0.38	4.41±0.19	6.89±0.80	242.22±11.43	25.78±1.50	63.11±1.64	3.33±0.31	7.78±0.77	66.50±0.89	22.66±0.30	22.17±0.50
Yankasa 6	31.20±1.51	10.40±0.51	4.86±0.25	8.64±1.08	208.40±15.34	25.80±2.02	64.20±2.20	2.80±0.41	7.20±1.04	64.24±1.19	25.33±0.64	21.42±0.41
R-V	27-45	8-16	9-16	4-12	100-500	2-9	2-9	0-1	0-0.75	102.02-112.40	35.07-37.23	30.4-32.65

[a,b] Means across the row bearing distinct characters differ significantly (P<0.05)

Table 8: Interaction Effect of Breed and Age on Serum Biochemistry Profile in the Nigerian Indigenous Sheep Breeds

BREED	AGE (Years)	AST (u/l)	ALT (u/l)	ALP (u/l)	Ca (mm/l)	UR (mm/l)	CR (mm/l)	TC (mm/l)	TP (g/l)	ALB (g/l)	Mag (mg/dl)	Phos (mg/dl)
WAD	2	125.25±23.55	35.25±9.76	6.00±0.19	4.68±0.13	2.95±0.09	178.50±1.32	2.18±0.10	69.50±0.65	34.00±1.47	2.30±0.11	5.40±0.20
WAD	4	130.00±8.66	34.00±3.88	7.53±0.58	7.24±0.53	5.08±0.32	180.89±0.59	2.10±0.20	71.11±1.33	28.33±1.13	2.41±0.08	7.06±0.57
WAD	6	115.00±5.00	27.00±6.00	7.70±0.3	10.00±0.40	3.30±0.40	179.50±1.50	1.90±0.10	69.50±0.50	30.50±4.50	2.85±0.65	6.70±0.20
YANKASA	2	142.50±9.65	40.67±3.82	7.65±0.69	7.22±0.74	5.68±0.98	181.50±1.18	1.95±0.15	64.50±2.03	42.17±2.96	2.22±0.08	5.35±0.13
YANKASA	4	153.11±4.63	39.89±1.53	6.92±0.23	7.01±0.30	5.17±0.47	179.33±0.47	2.16±0.09	65.44±1.93	27.00±2.27	3.62±0.39	6.98±0.46
YANKASA	6	142.00±21.17	40.20±9.68	9.66±0.29	6.90±0.08	6.30±1.03	180.00±0.63	2.12±0.13	62.80±0.97	30.60±2.87	2.24±0.93	7.70±0.53
UDA	2	162.00±0.00	37.00±0.00	6.80±0.00	5.10±0.00	9.50±0.00	191.00±0.00	1.30±0.00	70.00±0.00	29.00±0.00	5.60±0.00	9.00±0.00
UDA	4	178.40±7.20	44.60±2.14	7.40±0.30	7.76±0.23	6.52±0.22	183.80±0.8	2.52±0.04	66.6±2.71	25.4±1.86	2.24±0.05	6.92±0.68
UDA	6	88.50±10.5	14.00±1.00	7.65±0.05	8.95±0.25	5.40±2.00	181.50±0.5	2.45±0.25	59.00±1.00	20.00±2.00	4.75±0.45	7.90±01.10
BALAMI	2	104.00±0.00	22.00±0.00	7.90±0.00	6.10±0.00	10.20±0.00	182.00±0.00	2.60±0.00	61.00±0.00	19.00±0.00	3.20±0.00	8.40±0.00
BALAMI	4	107.00±3.00	19.00±4.00	9.15±0.45	6.75±2.05	5.00±0.80	185.50±4.50	2.30±0.30	65.00±2.00	26.00±6.00	4.75±1.05	5.90±0.30
BALAMI	6	110.00±0.00	17.00±0.00	5.00±0.00	7.80±0.00	7.10±0.00	191.00±0.00	1.90±0.00	69.00±0.00	35.00±0.00	3.90±0.00	4.70±0.00

AST- Aspartate aminotransferase, ALT-Alanine aminotransferase, ALP- Alkaline phosphatase, CA- Calcium, UR- Urea, TP- Total protein, ALB-Albumin, Mag- Magnesium, Phos-Phosphorus, TC-Total cholesterol, CR- Creatinine

Conclusion and Applications

1. The research affirmed that breed, age & sex had an influence on hematological and serum parameters.
2. Further studies with more samples trial should be considered to compliment the information obtained, which could be used to monitor animal health condition in order to improve the management and conservation of animal genetic resources for the breed studied.
3. Optimal level of PCV and AST at age 4 was within the normal range for hematological and serum parameters while variation was observed both at younger age and as the animal advances in age.

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