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Effect of Sex and Age on Blood Traits of West African Dwarf Goat in the Humid Tropics

***[1]Nosike, R. J., [1]Nwaokoro, C. C., [2]Okonkwo, I. E. and [1]Nwakpu, O. F.**

[1]Department of Animal Breeding and Physiology,
Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria
[2]Department of Agricultural Extension and Management,
Federal College of Agriculture Ishiagu, Ebonyi State, Nigeria
*Corresponding Author's email: nosikereginald@gmail.com

Abstract
West African Dwarf (WAD) goats (8 Bucks and 8 Does) at average age of 18 weeks were used for the study to determine the effect of sex and age on blood traits in the humid tropics. Blood traits measured were packed cell volume (PCV %), haemoglobin (HB g/dL), red blood cell (RBC $x10^6mm^3$), total white blood cell (TWBC $x10^3mm^3$), total protein (TP g/dL), blood glucose (BG mg/dL), Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular Haemoglobin Concentration (MCHC). Data collected was subjected to Student's t-Test analysis and Analysis of variance (ANOVA). There were significant ($p<0.05$) differences in the effect of sex on PCV and RBC at 22 weeks of age (WOA). There was high significant ($p<0.01$) difference on the effect of sex on MCH at 25 WOA. Blood traits of goats at 21 to 26 WOA showed significant ($p<0.05$) differences. There were increases in (HB) from 10.05-12.30g/dL, PCV (20.00-25.00%), RBC (5.83-7.41$x10^6$) and TP (6.64-7.36g/dL) from 21 to 26 WOA. There was significant difference ($p<0.05$) in HB with highest amount in week 22-26. There was significant difference ($p<0.05$) in PCV, RBC and TP values with WAD goats having the highest amounts at 23-26 weeks of age. There was no significant difference ($p>0.05$) in TWBC across the ages. There was significant difference ($p<0.05$) in BG with goats having the highest amounts at 25 WOA. The study has revealed that sex and age have influences on blood traits of WAD goats in the humid tropical environment.

Keywords: WAD goat, sex, age, blood traits

Introduction

Goat production in Nigeria is essentially a traditionally activity in which household units feature prominently (Ajala, 1998). Blood is an important and reliable medium for assessing the health status of individual animal (Merck Manual, 2012). Haematological parameters are good indicators of the physiological status of animals (Khan and Zafar, 2005). As reported by Isaac *et al.* (2013) animals with good blood composition are likely to show good performance. The formation of blood cells (haemopoiesis) is determined by the interaction of multiple genes and involves cytokines and other protein factors (Munker *et al*., 2007). Nutrition, age, sex, genetics, stress, and transportation are all known to affect haematological and biochemical parameters observed between tropical and temperate animals (Ogunsanmi *et al*., 1994). The West African Dwarf goats (WAD) are found in the region, south of latitude 14^0N across West Africa in the coastal area which is humid and favours high prevalence of diseases (Adeloye, 1998). This eco-zone is infested with tsetse flies and WAD goats are trypanotolerant. There is a great variation in the haematological and biochemical parameters as observed between breeds of goats (Azab and Abdel-Maksoud, 1999; Tambuwal *et al*., 2002) and in this regard it may be difficult to formulate a universal metabolic profile test for goats. As limited information is available regarding the blood traits profile of WAD goat from South-eastern part of Nigeria as affected by age and sex forms the basis of this study. The objective of the study was therefore to evaluate the effect of sex and age on the blood traits of WAD goats in the humid tropics.

Materials and Methods

The study was conducted at the Goat Section of the Small Ruminant Unit of the Teaching and Research Farm of Michael Okpara University of Agriculture Umudike, Abia State. Umudike is located on latitude 05^0C 28′ North and 07^0C 32′East and lies at an altitude of

122m above sea level. This area is situated within the tropical rainforest zone of West Africa which is characterized by long duration of rainfall (April - October) and short period of dry season (November-March). Average rainfall is 2169.8 mm in 148 – 155 rain days. Average ambient temperature is 26^0C with a range of 22^0C and 30^0C. Its relative humidity ranges from 50% to 90%. These data were obtained from the meteorological station at the National Root Crops Research Institute (NRCRI, 2017).

Experimental Animals and Management

A total of 16 grower WAD goats were purchased from individual farms in Abia state, Nigeria. The experimental animals were quarantined on arrival and allowed to acclimatize to their new environment for two weeks. During the period ages of the goats were determined using dentition method by counting the number of rusted incisor teeth (which differentiates the milk teeth from the permanent). The animals were routinely sprayed with acaricides to control Ecto-parasites, they were dewormed regularly, then vaccinated against pest des petit-ruminant (PPR). The goats were managed intensively and allowed to fresh clean water. They were fed with varieties of forages such as: *Panicum maximum*, *Centrocema pubences*, *Alcornea cordifolia*, *Gliricidia sepium*, hay and other brows plants. Feed was provided *ad-lithium*. The female animals were housed separate from male goats and provided with an open space, the animals were maintained in this condition for two weeks prior to blood sampling. The experiment lasted for 12weeks.

Experimental Procedures

Experimental Design

For effect of sex on blood traits of WAD goats:

The experiment was a two-sample t-test (Snedecor and Cochran, 1982).

The statistical formula was given as:

$$T = \frac{Y_1 - Y_2}{\sqrt{S\frac{1}{2}/N_1 + S\frac{2}{2}/N_2}} \quad \ldots\ldots 1$$

Where; N_1 and N_2 are the samples, Y_1 and Y_2 are the sample means and $S\frac{1}{2}$ and $S\frac{2}{2}$ are the pooled variances.

***For effect of age on blood traits of WAD goats*:**

The experiment was designed as a Completely Randomized Design (CRD) with age as a major factor of interest.

The statistical model is given thus:

$$\mathbf{Y_{ij} = \mu + A_i + e_{ij}} \quad \ldots\ldots\ldots \mathbf{(2)}$$

Where; Y_{ij}= individual observation, μ= Overall mean, A_i = effect of age (i=21, ,..,, 26) weeks, e_{ijk}=Random error, assumed to be independently, identically and normally distributed with zero mean and constant variance [iind $(0,\sigma^2)$].

Data Collection

Data was collected on a weekly basis during the experiment.

Blood Collection and Determinations

The goats were bled through their jugular vein and 4mls of blood was collected bi-weekly. 1ml of the blood sample was collected into a plastic tube containing EDTA for haematological studies. The remaining 3mls of blood samples was deposited in anticoagulant free plastic tubes and stored at -20^0C for biochemical studies.

Packed cell volume (PVC): The PVC was determined by the micro heaematocrit method (Thrall and Wiser, 2002).

Haemoglobin concentration (Hb): The HB concentration was determined by the cyanomethaemoglobin method (Higgins *et al*., 2008).

Erythrocyte (Red blood cell) count: The Erythrocyte was determined with a haemocytometer using a diluting fluid (Coles, 1986; Thrall and Weiser, 2002).

Total Leukocyte (WBC) Count: The total leukocyte count was also determined with a haemocytometer, using a diluting fluid (Coles, 1986; Thrall and Weiser, 2002).

Total protein: The Serum total protein was determined by the direct Bitter method (Johnson, 2008) using a reagent kit.

Blood glucose: Blood glucose (BGC) determination was by the process described by Barker and Silverton (1976).

Statistical Analysis

Mean values and standard errors of blood traits were calculated and compared statistically using student's T-test assessing the mutual statistical differences between Sexes of WAD goats (Snedecor and Cochran, 1982).

The data generated from blood traits were subjected to analysis of variance (ANOVA) to evaluate age effect. Significant differences among means were separated using Duncan's Multiple Range Test Procedure (Duncan, 1955).

Results and Discussion

Effect of Sex on the Blood Traits of WAD Goats at 21 weeks of Age

The effect of sex on the blood traits of WAD goats at 21 week of age is presented in Table 1. All the blood traits were comparable ($p>0.05$) between males and females at 21 weeks of age.

The non-significant difference in Table 1 for goats at 21 WOA showed that sex cannot be used to differentiate between WAD goats at early stage of life. The values obtained fell within the range reported by previous researchers on goats Tambuwal *et al.* (2002). However, the numerical values showed that female WAD goats were higher than males in Hb, PCV, RBC and TWBC. These indicate a boost to the growth, productive life, and a well-developed immune system in female WAD goats.

Effect of Sex on the Blood Traits of WAD Goats at 22 weeks of Age

The effect of sex on the blood traits of WAD goats at 22

Week of Age is presented in Table 2. All the blood traits were similar ($p>0.05$) between both sexes, except packed cell volume (PCV) and red blood cell (RBC) which differed significantly ($p<0.05$) at 22 weeks of age. Packed cell volume (PCV) in this study was significantly ($p<0.05$) higher in females (24.00%) than males (20.50%). Red blood cell (RBC) counts in this study was significantly ($p<0.05$) higher in males ($9.93x10^6$) than females ($6.909.93x10^6$). In Table 2, the findings of this study support that PCV varies among breeds of goats. The values obtained were within the range obtained for Red Sokoto goats (Tambuwal *et al*., 2002). Patterson *et al.* (1960) attributed increase in PCV values in goat to increase in environmental temperature. This finding suggested that WAD goats have tendency for compensatory accelerated production (CAP) of PCV in case of infection and stress. Compensatory accelerated production has been shown to return PCV to normal following an infection (Dargie and Allonby, 1975). The significant increase in RBC counts in males than females could be a function of high levels of testosterone in adult male animals (Sturkie, 1986), which stimulate erythropoiesis (Villers and Dunn, 1998). Differences in blood parameters may be caused by nutrition, environment, and hormonal factors (Chineke *et al*., 2002).

Effect of Sex on the Blood Traits of WAD Goats at 23 weeks of Age

The effect of sex on the blood traits of WAD goats at 23 weeks of age is presented in Table 3. All the blood traits were comparable ($p>0.05$) between both Bucks and Does at 23 weeks of age. The effect of sex on the blood traits of WAD goats at 23 Week of Age is presented in Table 3. The values obtained fell within the range reported by previous researchers on goats Tambuwal *et al.* (2002). However, the numerical values showed that female WAD goats were higher than males in Hb, suggesting that the oxygen carrying capacity of the blood was high in female goats. The result also showed an improvement in the blood traits as the animals advanced in age. WAD goats seem to possess protective system, providing a rapid and potent defence against any infectious agent and this is probably the physiological basis for the adaptation of this species to this ecological zone characterized by high prevalence of diseases.

Effect of Sex on the Blood Traits of WAD Goats at 24 weeks of Age

The effect of sex on the blood traits of WAD goats at 24 Week of Age is presented in Table 4. All the blood traits were similar ($p>0.05$) between both sexes, except MCHC which differed significantly ($p<0.05$) at 24 weeks of age. The values obtained were significantly ($p<0.05$) higher in males (47.09g/dl) than in females (46.15g/dl). The effect of sex on the blood traits of WAD goats at 24 Week of Age is presented in Table 4. The values obtained were within the range obtained for Red Sokoto goats (Tambuwal *et al*., 2002). MCHC help to know the amount of haemoglobin relative to the size of the cell per red blood cell (Bounous and Stedman, 2000). The function of RBC is to transport oxygen from the lungs to tissues and remove carbon dioxide from the tissues to the lung in the body via haemoglobin.

Effect of Sex on the Blood Traits of WAD Goats at 25 weeks of Age

The effect of sex on the blood traits of WAD goats at 25 weeks of age is presented in Table 5. There was no significant ($p>0.05$) difference between both sexes at 25 weeks of age in all blood parameters studied. The effect of sex on the blood traits of WAD goats at 25 Week of Age is presented in Table 5. The values obtained fell within the range reported by previous researchers on goats Tambuwal *et al.* (2002). However, the numerical values showed that female WAD goats were higher than males in all the parameters. This could be caused by nutrition, environment, hormonal factors, and genetic makeup of the animals (Chineke *et al*., 2002). The WBC aids to protect the body from pathogen and build up the immune system of the animals (Osman *et al*., 2004; Saladin, 2003). These indicate a boost to the growth and productive life in female WAD goats.

Effect of Sex on the Blood Traits of WAD Goats at 26 weeks of Age

The effect of sex on the blood traits of WAD goats at 26 weeks of age is presented in Table 6. All the blood traits were similar ($p>0.05$) between both sexes, except MCHC which differed significantly ($p<0.05$) at 26 weeks of age. The values obtained were significantly ($p<0.05$) higher in males (49.80g/dl) than in females (48.63g/dl). The effect of sex on the blood traits of WAD goats at 25 weeks of age is presented in Table 5. The values obtained fell within the range reported by previous researchers on goats Tambuwal *et al.* (2002). However, the numerical values showed that female WAD goats were higher than males in all the parameters. This could be caused by nutrition, environment, hormonal factors, and genetic makeup of the animals (Chineke *et al*., 2002). The WBC aids to protect the body from pathogen and build up the immune system of the animals (Osman *et al*., 2004; Saladin, 2003). These indicate a boost to the growth and productive life in female WAD goats.

Effect of Age on the Blood Traits of WAD Goat at weeks 21 to 26

Effect of age on the blood traits of WAD goat at weeks 21 to 26 are shown in Table 7. Haemoglobin (Hb) increased from 10.05 to 12.30g/dl, PCV increased from 20.00 to 25.00%, RBC increased from 5.83 to $7.41x10^6$ and total protein increased from 6.64 to 7.36g/dl as the goat advance from 21 to 26 weeks of age. There was significant difference ($p<0.05$) in Haemoglobin concentration with goat having the highest amount in week 22-26. There was significant difference ($p<0.05$) in PCV and RBC values with WAD goats having the highest amounts at 23-26 weeks of age. There was no significant difference ($p>0.05$) in TWBC across the ages indicating stable health conditions throughout. There was significant difference ($p<0.05$) in MCH and MCV values with goats having the highest amounts at 22 and 23 weeks of age respectively. There was significant

difference ($p<0.05$) in blood proteins with WAD goats having the highest amounts at 23-26 weeks of age. There was significant difference ($p<0.05$) in blood glucose with goats having the highest amounts at 25 weeks of age.

Effect of Sex on the Blood Traits of WAD Goats at 26 weeks of Age

The effect of sex on the blood traits of WAD goats at 26 Week of Age is presented in Table 6. The values obtained were within the range obtained for Red Sokoto goats (Tambuwal *et al*., 2002). MCHC help to know the amount of haemoglobin relative to the size of the cell per red blood cell (Bounous and Stedman, 2000). The function of RBC is to transport oxygen from the lungs to tissues and remove carbon dioxide from the tissues to the lung in the body via haemoglobin.

Effect of Age on the Blood Traits of WAD Goat at weeks 21 to 26

Effect of age on the blood traits of WAD goat at weeks 21 to 26 are shown in Table 7. Haemoglobin (Hb) increased from 10.05 to 12.30g/dl, PCV increased from 20.00 to 25.00%, RBC increased from 5.83 to $7.41x10^6$ and total protein increased from 6.64 to 7.36g/dl as the goat advance from 21 to 26 weeks of age. This suggests a boost to the growth, productive life, and a well-developed immune system in the WAD goats with advancement in age (Olusanya *et al*., 1976). However, the values obtained in this study fell within the range recorded for Red Sokoto goats (Tambuwal *et al*., 2002). In Table 7, the higher Hb in the goats implies proper oxygen transportation to body tissues and removing waste carbon dioxide. Lowest amount of Hb was recorded at 21 weeks of age which indicates low oxygen in tissues. Hb also plays an important role in maintaining the pH of the blood. RBCs transport Hb. Reduction of Hb or of RBCs results in low oxygen in tissues, causing short breath, a symptom of anaemia. Total White Blood Cells (TWBC) are cells of the immune system involved in defending the body against both infections, disease, and foreign materials (Tambuwal *et al*., 2002). The non-significant difference in the total WBC also showed that the numerical values decrease as the animals advance in age. Valencia (2012) and Braun (2013) reported that a high white blood cell count could be caused by infection, immune system disorders, and stress among others. However, these may not the case in this study as the WBC levels were not fluctuating, thus, improving the immune system of the animals.

Mean Corpuscular Haemoglobin Concentration (MCHC) obtained in this study were within the normal range reported by Tambuwal *et al.* (2002). MCHC is a measure of the concentration of haemoglobin in a given volume of packed red blood cells. It is very significant in the diagnosis of anaemia and serve as a useful index of the capacity of the bone marrow to produce red blood cells. Merck Manual (2012) reported that the normal ranges of values for MCV and MCH for goats are 35 - 55, and 13 - 20 respectively, which is within the range recorded in this study, MCV (35.18 to 36.62) and MCH (16.07 to 18.23). The result showed that the MCV and MCH levels decrease with advancement in age, thus, suggestive of growth and productive life of the animals.

Conclusion

The result revealed that sex and age are important sources of variation for blood traits. In this study females had mostly higher blood trait values than male goats through week 21 to 26. In View of the results obtained in this study, it is recommended that further research studies should be done on WAD goats from different ecological zones of southern Nigeria to determine effect of sex and age on blood traits.

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Table 1: Effect of sex on the blood traits of WAD goats at 21 Weeks of Age

Blood trait	N	Sex		Significance
		Male	Female	
Hb (g/dl)	8	9.60 00	10.5000	0.237 ^{NS}
PCV (%)	8	18.5000	21.5000	0.198 ^{NS}
RBC (x10^{6}mm^3)	8	5.4200	6.2450	0.174 ^{NS}
TWBC (x10^{3}mm^3)	8	16.1500	14.1750	0.168 ^{NS}
MCV(fl)	8	36.1100	36.1500	0.909 ^{NS}
MCH (pg)	8	17.7100	16.8250	0.066 ^{NS}
MCHC (g/dl)	8	51.9000	48.9150	0.119 ^{NS}
Total Protein (g/dl)	8	6.6350	6.6400	0.984 ^{NS}
Glucose (mg/dl)	8	61.0000	62.5000	0.776 ^{NS}

NS = Not significant, Hb = Haemoglobin, PCV = Packed Cell Volume, RBC = Red Blood Cell, TWBC = Total White Blood Cell, MCV =Mean Corpuscular Volume, MCH = Mean Corpuscular Haemoglobin, MCHC = Mean Corpuscular Haemoglobin Concentration

Table 2: Effect of sex on the blood traits of WAD goats at 22 Weeks of Age

Blood trait	N	Sex		Significance
		Male	Female	
Hb (g/dl)	8	11.2	12.10	0.057 ^{NS}
PCV (%)	8	20.50	24.00	0.020 *
RBC (x10^{6}mm^3)	8	5.93	6.90	0.015 *
TWBC (x10^{3}mm^3)	8	13.45	17.30	0.149 ^{NS}
MCV (fl)	8	36.42	36.35	0.799 ^{NS}
MCH (pg)	8	18.92	17.54	0.204 ^{NS}
MCHC (g/dl)	8	54.69	50.32	0.201 ^{NS}
Total Protein (g/dl)	8	6.76	6.95	0.376 ^{NS}
Glucose (mg/dl)	8	61.50	61.50	1.000 ^{NS}

NS = Not significant, * Significant at p< 0.05. Hb = Haemoglobin, PCV = Packed Cell Volume, RBC = Red Blood Cell, TWBC = Total White Blood Cell, MCV = Mean Corpuscular Volume, MCH = Mean Corpuscular Haemoglobin, MCHC = Mean Corpuscular Haemoglobin Concentration

Table 3: Effect of sex on the blood traits of WAD goats at 23 Weeks of Age

Blood trait	N	Sex		Significance
		Male	Female	
Hb (g/dl)	8	11.80	12.10	0.493 ^{NS}
PCV (%)	8	24.50	24.00	0.423 ^{NS}
RBC ($x10^6mm^3$)	8	7.00	6.85	0.497 ^{NS}
TWBC ($x10^3mm^3$)	8	15.90	14.65	0.126 ^{NS}
MCV (fl)	8	36.58	36.67	0.830 ^{NS}
MCH (pg)	8	16.86	17.68	0.305 ^{NS}
MCHC (g/dl)	8	48.17	50.42	0.216 ^{NS}
Total Protein (g/dl)	8	7.64	7.25	0.072 ^{NS}
Glucose (mg/dl)	8	66.00	71.00	0.050 ^{NS}

Table 4: Effect of sex on the blood traits of WAD goats at 24 Weeks of Age

Blood trait	N	Sex		Significance
		Male	Female	
Hb (g/dl)	8	12.00	12.00	1.00 ^{NS}
PCV (%)	8	25.50	26.00	0.423 ^{NS}
RBC ($x10^6mm^3$)	8	7.52	7.41	0.527 ^{NS}
TWBC ($x10^3mm^3$)	8	13.15	14.05	0.555 ^{NS}
MCV (fl)	8	35.34	36.58	0.132 ^{NS}
MCH(pg)	8	15.96	16.18	0.355 ^{NS}
MCHC(g/dl)	8	47.06	46.15	0.023 *
Total Protein (g/dl)	8	7.09	7.32	0.392 ^{NS}
Glucose (mg/dl)	8	69.00	67.50	0.312 ^{NS}

Table 5: Effect of sex on the blood traits of WAD goats at 25 weeks of Age

Blood trait	N	Sex		Significance
		Male	Female	
Hb (g/dl)	8	12.00	12.30	0.831 ^{NS}
PCV (%)	8	24.00	24.00	1.000 ^{NS}
RBC ($x10^6mm^3$)	8	7.07	7.00	0.797 ^{NS}
TWBC ($x10^3mm^3$)	8	14.05	14.73	0.732 ^{NS}
MCV (fl)	8	35.47	35.85	0.378 ^{NS}
MCH (pg)	8	17.27	17.58	0.010 ^{NS}
MCHC (g/dl)	8	50.85	51.25	0.582 ^{NS}
Total Protein (g/dl)	8	7.29	7.41	0.746 ^{NS}
Glucose (mg/dl)	8	70.00	76.00	0.115 ^{NS}

Table 6: Effect of sex on the blood traits of WAD goats at 26 Weeks of Age

Morphometric traits	N	Sex		Significance
		Male	Female	
Hb (g/dl)	8	12.20	12.40	0.553 ^{NS}
PCV (%)	8	24.50	25.50	0.293 ^{NS}
RBC ($x10^6mm^3$)	8	7.29	7.52	0.136 ^{NS}
TWBC ($x10^3mm^3$)	8	15.63	13.80	0.164 ^{NS}
MCV (fl)	8	35.04	35.32	0.700 ^{NS}
MCH (pg)	8	16.74	16.50	0.397 ^{NS}
MCHC (g/dl)	8	49.80	48.63	0.047 *
Total Protein (g/dl)	8	7.30	7.42	0.647 ^{NS}
Glucose (mg/dl)	8	71.50	73.50	0.445 ^{NS}

Table 7: Effect of age on the blood traits of WAD goat at weeks 21 to 26

Age (Week)	Hb (g/dl)	PCV (%)	RBC ($x10^6$ mm^3)	TWBC ($x10^3$ mm^3)	MCV	MCH	MCHC (g/dl)	Total protein (g/dl)	Glucose (mg/dl)
21	10.05^{b}± 0.68	20.00^{c}±2 .16	5.83^{c}±0. 58	15.16±1 .37	36.13^{ab}± 0.25	17.27^{b}±0 .55	50.41^{ab}± 1.96	6.64^{b}±0 .18	61.75^{c}±3 .86
22	11.65^{a}± 0.55	22.25^{b}± 2.06	6.41^{b}±0. 57	15.38±2 .61	36.38^{ab}± 0.20	18.23^{a}±1 .00	52.50^{a}±3 .16	6.85^{b}±0 .18	61.50^{c}±1 .29
23	11.95^{a}± 0.34	24.25^{ab}± 0.50	6.92^{ab}±0 .18	15.28±0 .83	36.62^{a}±0 .32	17.27^{b}±0 .68	49.29^{b}±1 .66	7.44^{a}±0 .23	68.50^{b}±3 .11
24	12.00^{a}± 0.16	25.75^{a}±0 .50	7.46^{a}±0. 13	13.60±1 .17	35.96^{ab}± 0.82	16.07^{c}±0 .20	46.61^{c}±0 .54	7.20^{a}±0 .22	68.25^{b}±1 .29
25	12.25^{a}± 0.34	24.00^{ab}± 0.82	7.03^{a}±0. 20	14.39±1 .45	35.66^{bc}± 0.38	17.43^{ab}± 0.18	51.05^{ab}± 0.55	7.35^{a}±0 .26	73.00^{a}±3 .92
26	12.30^{a}± 0.26	25.00^{a}±0 .82	7.41^{a}±0. 15	14.71±1 .26	35.18^{c}±0 .54	16.62^{c}±0 .23	49.22^{b}±0 .71	7.36^{a}±0 .20	72.50^{ab}± 2.08

^{abc} ***Means in the same column with different superscripts are significantly ($p<0.05$) different.***
Hb = Haemoglobin, PCV = Packed Cell Volume, RBC = Red Blood Cell, TWBC = Total White Blood Cell, MCV = Mean Corpuscular Volume, MCH = Mean Corpuscular Haemoglobin, MCHC = Mean Corpuscular Haemoglobin Concentration.