Niger. J. Physiol. Sci. 30(2015) 111-118
www.njps.com.ng

Niger. J. Physiol. Sci.

Baseline Haematology and Erythrocyte Morphological Changes of Apparently Normal Dogs Raised in Ibadan, Oyo State

***Adekola A.A., Jagun A.T., Emikpe B.O., Antia R.E**

Department of Veterinary Pathology, University of Ibadan. Nigeria Ibadan, Nigeria.

Summary: This study evaluates the haematological parameters and the observed erythrocytes morphological changes in dogs raised in Ibadan, Oyo State in the south western part of Nigeria. Blood samples were collected from sixty-four apparently healthy dogs. The haematological parameters of the blood samples collected were evaluated with the quantification of the percentage erythrocyte morphological abnormalities. The result of the quantitative count of the erythrocyte morphological abnormalities were also converted using reference guide to give the numerical/descriptive clinical grade of the associated morphological abnormalities. There was a significant difference between the haematological parameters reported in this study and the commonly used dog haematological reference ranges from temperate regions used in laboratories in Nigeria. Some of the morphological abnormalities observed in this study include echinocyte (4.12±0.35%), macrocyte (2.61±0.22%) and spherocyte (2.17±0.29%) and eccentrocyte (0.39±0.06%) while other such as acanthocyte (1.39±0.19), leptocyte (0.71±0.13), schizocyte (0.703±0.104) and codocyte (0.50±0.11) were also seen. These study findings show that the associated morphological changes were all not significant and fall within the acceptable range using the reference guide for erythrocyte morphological abnormalities even when the haematological values differ significantly from the reference value. This study provides baseline information on the haematological parameters and the novel correlation of the associated erythrocyte abnormalities seen as a corresponding proof of the apparently healthy status of the dogs raised in Ibadan used for this study. The study while serving as an important means of verification of the reference range of haematological parameters also shows that clinical case interpretation using haematological baseline data from the temperate region should be used with caution in our tropical environment. This thus necessitates the need for an advocacy to build a reference range of haematological parameters that can be used as a working baseline value for the tropical environment.

Keywords*:* Haematological parameters, Erythrocyte morphological changes, South Western Nigeria

**Address for correspondence:* adewoleadekola@gmail.com Tel: +2348063171963

Manuscript Accepted: September, 2015

INTRODUCTION

The use of the quantitative and qualitative evaluation of the haematological parameters of animals and humans has been a vital indicator of the physiological and general well-being for clinical and research purposes. The vital role of the changes in the haematological parameters from the normal values associated with the changes in the internal milieu of the animal or man has thus been a strong basis for its use (Kumar *et al.*, 2005). In clinical practice, the information derived from both the quantitative and qualitative evaluation of the haematological parameters are often used to corroborate the physical examination and the medical history to provide excellent basis for medical diagnosis (Harvey 2012). This evaluation when done to encompass the haematological, haematochemical parameters of the blood metabolites and other component of the body serves as an important investigative tool in the clinical assessment of the physiological and pathological status (Aderemi, 2004; Doyle, 2006). This along with its relatively minimal invasiveness makes it a good means of measuring potential biomarkers (Ginsbury and Haga, 2006), evaluation of the physiological status of the animal (Khan and Zafar, 2005), evaluation of the physiological and pathological responsiveness of animals to pathological and managemental factors arising from changes in the internal milieu and other environmental factors (Khan and Zafar, 2005; Weiss et al., 2010)

Due to the effect of several managemental factors such as stress, nutrition, housing and management system on the haematological parameters, changes in haematological parameters can thus be used to evaluate the effect of stressors and the deviation of an animal from the normal to the stress state (Aderemi, 2004), the evaluation of the nutritional state and the welfare of animals (Jain *et al.*, 1975; Khan *et al.*, 2005; Etim *et al.*, 2014).

A review of literature has shown a plethora of information indicating that researchers have reported data on the haematological parameters (Mshelia *et al.*, 2005; Olayemi *et al.*, 2009) and haematochemical parameters (Awah and Nottidge, 1998; Piccione *et al.*,

2010). Some dog breeds that have been used for these studies include the Nigerian local dogs (Omamegbe and Uche, 1985; Awah and Nottidge, 1998 and Ariyibi, 2002) and the exotic dog breeds also raised in the environment (Awah and Nottidge, 1998; Ariyibi *et al.,* 2002). However, very little information is available on the associated morphological abnormalities of canine blood cells and their role in evaluation and adjudging the normality of haematological parameters and in clinical diagnosis in Nigeria. Disease, infection, genetic disorders, and variations in blood chemistry can alter the RBC shape, reducing its ability to bend and deform (Chien 1987). Abnormal RBC morphologies can impede or even obstruct the circulation, causing tissue necrosis in severe cases (Harvey, 2012). The examination of the blood film for the qualitative assessment of the blood should include blood smear examination for digression from normal of the cell size, shape, distribution, haemoglobin concentration, colour, and intracellular inclusions (Jones, 2009). The detection of these abnormal morphologies and its resultant delineation as either artifactual or pathological finding thus serves as an important means of ascertaining the clinical significance of such abnormal changes. The detected abnormal morphology can thus be correlated with the quantitative values of the haematological parameters for arriving at a more holistic clinical diagnosis (Jones, 2009 and Barger, 2010). As part of measures in the assessment of the blood smear, there is usually a need for a documented protocol for the examination of blood smear for erythrocyte morphological abnormalities. This is important as it serves to provide additional information to the clinician to aid diagnosis and in the institution of the right treatment course. The evaluation of the erythrocyte morphological abnormalities in different laboratories are usually done using either qualitative remarks (few or marked) or a numerical grading (1+ to 4+) based on percentage of variation. There is also a need to describe the type of cell or cells that have caused the variation from the normal (Walton, 1973 and Weiss, 1984). This aids in offering a visual assessment of the blood smear to the clinician to facilitate a more concise diagnosis based on the haematological parameters. However, due to the manual method used in the assessment of the erythrocyte abnormalities, the evaluation is essentially subjective and as such it is important that laboratories establish guidelines based on their patient population (Kaplan, 2003 and Jones, 2009). There is also an important correlation between pathologic processes and the presence of erythrocyte morphological abnormalities (Kaplan, 2003; Jones, 2009 and Barger, 2010).

More so, many laboratories and veterinary clinics in Nigeria uses the standard reference values from foreign laboratories and those obtained from animals raised in temperate regions. These values are not always reliable since the physiological and haematological parameters of apparently healthy dogs are subject to considerable variations due to factors such as physiological state (e.g. lactation, pregnancy), age, sex, breed, nutrition, seasonal variations, sub clinical diseases and climate (Awah and Nottidge 1998). The adoption of such foreign haematological parameters reference intervals for the interpretation of the haematological data for indigenous and exotic breeds raised in our environment may therefore not give an accurate and precise representation of the animal's health status.

This therefore necessitates the need for feasible baseline and verification of the existing foreign haematological values for dogs of all breeds raised in our tropical environment and a measure of the correlation with other erythrocyte morphological indices in assessing the health status of the animals. Therefore, this study evaluates the baseline haematological values for dogs and correlates this with the erythrocyte morphological abnormalities observed in the blood collected from apparently healthy dogs raised in Ibadan, Oyo State, Nigeria

MATERIALS AND METHODS

Study area and sampling procedure

The study was carried out in Ibadan, Oyo State in the South Western part of Nigeria. The area is located in the humid and tropical wet and dry climate with a lengthy wet season and relatively constant temperatures throughout the course of the year. The study was conducted in the month of August - September at the peak of the raining season.

Animals and Selection Criteria

The animals used for this study were apparently healthy large breeds of dogs presented at various clinics (the University of Ibadan Veterinary Teaching Hospital, Mokola Veterinary Hospital, Mokola, and Magma Veterinary Clinics, Bodija) in Ibadan for routine clinical health assessment and/or vaccination. In all the 64 dogs selected include the Nigeria Local Indigenous dog breeds (15) while the exotic dog breeds selected were the large dog breed size and they include: Alsatian (25), Boerboel (9) and Rottweiler (8), and others [Pitbull (3), Neopolitan mastiff (2), Caucasian (1), and Doberman (1)].

All the dogs selected were on a good plan of nutrition with adequate protein supplementation. The physiological parameters (respiratory rate, heart rate, temperature and capillary refill time) of the dogs were also taken for the assessment of the health status and only those with values within normal health range were selected for the study. Blood was collected when the animals were at rest and minimal effort was used in the restraint of the dogs to prevent stressing and agitating the dogs.

Excited and nervous dogs were excluded from the study. Dogs with ectoparasites (such as ticks, fleas) and cutaneous lesions during the physical examination were also excluded from the study. The blood smears and buffy coat smears were also screened for haemoparasites and haemoparasitaemic dogs were excluded from the study.

Sample Collection Procedure

Blood was obtained by venipuncture of the cephalic vein from the subject dogs to obtain whole blood using a 5 mls syringe and 23 gauge needles. About 3 mls of blood were collected and dispensed into heparinized bottles and rocked gentle to allow mixing of the blood with the lithium heparin anticoagulant for haematological analysis. Sampling was done between 8am and 11am to avoid the effect of diurnal variation on the haematological parameters. All the blood samples collected were transported using ice pack and analyzed within 3 hours of collection to reduce preanalytical artifactual errors while standard procedures were also observed in the analysis in order to reduce analytical artifactual errors (Lippi *et al.*, 2005; Harvey, 2012).

Sample/ Blood Analyses Procedures (Haematology)

Analysis of the collected blood samples was divided into the quantitative and qualitative quantification of the red cell, white cells and platelet parameters. The packed cell volume (PCV) was carried out using the microhaematocrit method while the haemoglobin concentration was carried out using the cyanmethaemoglobin method (Cork and Halliwell, 2002). The erythrocyte count was estimated by using the haematocytometer method while the erythrocyte indices (mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration) were calculated using the methods described by Jain (1993). The quantification of the morphological abnormalities was carried using the technique by Weiss 1984. The assessment of the peripheral blood smear for the erythrocyte morphology was done by viewing the thin portion of the smear. The thicker portion of the blood smear was avoided due to the overlap of cells while the edges of the smear where the cells could be artifactually distorted in shape, size and colour. red cells were using the light microscope immersion lens with 1000x magnification (Olympus BX 41) and the morphological abnormalities seen were counted using the tally counter. The values obtained were then converted to % abnormalities by using the formula below as in the case of Echinocytes:

$$\%\textbf{Echinocytes} = \frac{\boldsymbol{Echinocytes\ counted\ out\ of\ 200\ red\ cells\ in\ single}}{\mathbf{200}} \boldsymbol{X100}$$

This is repeated for all the observed morphological abnormalities to obtain the percentage count of each abnormality. The percentage morphological abnormalities obtained was there after scored using the reference guide by Weiss (1984) and Constantino (2015) to determine the severity and to adjudge normality of the animals.

The leucocyte (total white blood cell and differential leucocyte count) and platelet parameters were determined using standard procedures while the absolute leucocyte counts were calculated as described by Sastry (1985) and Coles (1986).

Statistical Analysis

The data collected was analyzed using SPSS v20 statistical package. All data were expressed as Means ± Standard Error of Means (S.E.M) for the measure of central dispersion while One - Way ANOVA was used for the comparison of more than two means at the 5% significance level. Statistical significance was assumed at the p - value of ($p < 0.05$).

RESULTS

Haematological Parameters

Table 1 shows the reference range of the haematological parameters obtained from the dogs used for this study compared with the reference range of the haematological parameters (obtained from dogs raised in the temperate) used in the clinical interpretation of haematological results.

Table1. Heamatological parameter in the studied dogs

Haematological Parameters	Mean±S.E.M	Standard Reference Range*
HB	11.12±0.33 [a]	12.00 - 18.00
RBC	5.61±0.18 [a]	5.50 - 8.50
PCV	34.72±1.04 [a]	37.00 - 55.00
MCV	62.21±0.55 [a]	60 - 77
MCH	20.24±0.65 [a]	19.50 - 24.50
MCHC	32.63±1.07 [1]	32.00 - 36.00
Platelet	1.87±0.10 [a]	2.00 - 5.00
Lymph	2.60±0.21 [1]	1.00 - 4.80
Neutr	6.12±0.47 [a]	3.00 - 11.50
Mono	0.28±0.04 [a]	1.50 - 1.35
Eosin	0.41±0.07 [a]	1.00 - 1.25
Basophil	0.01±0.00 [a]	0 - 140
Total WBC	9.42±0.54 [a]	6.00 - 17.00

Data from Weiss et al., (2010) PCV (%): Packed Cell Volume, Hb (g/dl): Haemoglobin Concentration, RBC (10^3/pL): Red Blood Cell, MCV (fl): Mean Cell Volume, MCH (%): Mean Cell Haemoglobin, MCHC (pg): Mean Cell Haemoglobin Concentration; WBC (*10^3/pL): White Blood Cell, PLT (*10^5/pL): Platelet Count, Lympho (*10^3/pL): Lymphocytes, Neutro (*10^3/pL): Neutrophils, Mono (*10^3/pL): Monocytes, Eosino (*10^3/pL): Eosinophils, Baso (*10^3/pL): Basophils *Where* $^a p < 0.01$ $^b p < 0.02$ $^c p < 0.05$**;** indicates not significant (P>0.05)

Table 2. Erythrocytic Series in the different study dog breeds

Source of Variation		RBC	PCV	HB	MCV	MCH	MCHC
BREED	Alsatian, n = 25	5.71±0.36	35.56±2.19	11.08±0.74	62.87±0.69	20.38±0.36	31.87±0.59
	Rottweiler, n =8	4.94±0.41	31.38±2.29	11.09±0.73	63.99±1.42	20.56±0.38	32.16±0.31
	Boerboel, n =9	5.34±0.39	32.22±2.15	10.19±0.67	60.55±0.64	19.16±0.29	31.66±0.39
	Local, n =15	5.53±0.39	33.67±2.30	11.43±0.70	61.13±0.88	22.18±2.70	36.29±4.37
	Others, n =7	5.70±0.47	36.00±2.26	11.37±0.68	64.10±2.13	20.29±0.77	31.64±0.29
Sex	Male, n =41	5.21±0.22	32.44±1.32	10.35±0.42	62.72±0.61	20.45±1.02	32.68±1.66
	Female, n =23	6.07±0.33	37.26±1.90	12.00±0.63	62.85±0.72	20.90±0.26	32.17±0.20
Age Group (years)	< 1 year, n=18	5.44±0.33	34.06±1.94	10.79±0.61	62.44±0.79	21.79±2.25	35.49±3.65
	1 - 5 years, n =37	5.67±0.26	35.19±1.52	11.02±0.51	62.71±0.63	20.52±0.29	35.49±3.65
	> 5 years, n =9	5.46±0.52	34.22±3.02	10.92±0.94	62.12±1.37	20.17±0.39	31.98±0.28

NS, indicates not significant (P>0.05); PCV (%): Packed Cell Volume, Hb (g/dl): Haemoglobin Concentration, RBC (10^3/pL): Red Blood Cell, MCV (fl): Mean Cell Volume, MCH (%): Mean Cell Haemoglobin, MCHC (pg): Mean Cell Haemoglobin Concentration [Others=Pitbull (3), Neopolitan mastiff (2), Caucasian (1), and Doberman (1)]

Table 3. Leucocytic series and Platelet parameters in the different study dog breed

Source of Variation		WBC	Neutro	Eosino	Baso	Mono	Lympho	Platelet
BREED	Alsatian, n = 25	9.27±0.98	5.76±0.84	0.40±0.10	0.00±0.00	0.27±0.07	2.83±0.41	1.85±0.18
	Rottweiler, n =8	9.76±1.56	6.52±1.45	0.79±0.34	0.00±0.00	0.29±0.10	2.16±0.65	1.80±0.29
	Boerboel, n =9	10.17±1.81	7.32±1.36	0.32±0.14	0.00±0.00	0.27±0.06	2.25±0.43	2.15±0.28
	Local, n =15	9.75±0.95	6.20±0.81	0.37±0.11	0.03±0.02	0.30±0.06	2.85±0.43	1.85±0.15
	Others, n =7	7.12±1.03	4.64±1.17	0.20±0.06	0.00±0.00	0.27±0.08	2.01±0.21	1.45±0.23
Sex	Male, n =41	8.89±0.65	5.82±0.57	0.37±0.08	0.01±0.01	0.25±0.04	2.44±0.28	1.74±0.11
	Female, n =23	10.13±1.00	6.47±0.84	0.49±0.12	0.01±0.00	0.32±0.08	2.84±0.32	2.02±0.18
Age Group (years)	< 1 year, n=18	8.94±0.78	5.69±0.70	0.46±0.16	0.01±0.01	0.27±0.05	2.51±0.33	1.81±0.16
	1 - 5 years, n =37	9.11±0.70	5.76±0.55	0.38±0.08	0.01±0.01	0.28±0.05	2.68±0.32	179±0.12
	> 5 years, n =9	11.04±2.23	8.02±2.06	0.42±0.15	0.00±0.00	0.29±0.11	2.31±0.43	2.14±0.36

WBC (*10^3/pL): White Blood Cell, PLT (*10^5/pL): Platelet Count, Lympho (*10^3/pL): Lymphocytes, Neutro (*10^3/pL): Neutrophils, Mono (*10^3/pL): Monocytes, Eosino (*10^3/gL): Eosinophils, Baso (*10^3/pL): Basophils

The haematological parameters obtained from the study dogs except the lymphocyte and the MCHC value were significantly different and lower than the standard reference range obtained from the foreign studies, however the reference range of the MCHC and the lymphocyte count were higher than those of the temperate region studies.

Table 2 shows and compares the values of the erythrocyte parameters (Red cell count, Haemoglobin concentration and packed cell volume) and the erythrocytic indices (MCV, MCH, MCHC) across the different breed groups, sex and the age group of the study animals. The values of the red cell, packed cell volume and the haemoglobin concentration was higher in the study female animals than in the male dogs used for this study thus showing a significant difference in the erythrocyte parameters between the sexes. There was also a significant difference in the erythrocyte parameters when compared across the different breeds even when they were raised in the same environment. An age group based difference was also seen in the erythrocyte parameters.

As shown below, Figure 3 gives the graphical representation of the observed erythrocyte morphological abnormalities in male and female dogs while Figure 4 gives the graphical representation of the observed morphological abnormalities across the different age groups. The erythrocyte morphological abnormalities of the dogs in the different age group and sex are both not clinically significant and do not indicate any pathological state when evaluated using the reference guide by Weiss (1984).

Table 4. shows the Mean ± S.E.M of the percentage of the erythrocyte morphological abnormalities seen in the study animals. These values were evaluated using the reference range for the adjudging the clinical descriptive and numerical values of the erythrocyte morphological abnormalities for clinical haematology case interpretation as described by Weiss (1984). The values of the dogs used for this study were found to be non-significant and within the normal range for healthy dogs. Figure 1 and Figure 2 shows some of the observed erythrocyte morphological abnormalities.

Table 4. Percentage Erythrocyte Morphological Abnormalities

Parameters	Mean±S.E.M
Eccentrocyte	0.391±0.064
Microcyte	1.063±0.136
Macrocyte	2.609±0.224
Spherocyte	2.172±0.285
Leptocyte	0.711±0.125
Polychromasia	0.891±0.112
Codocyte	0.500±0.111
Elliptocyte	1.258±0.120
Dacryocyte	0.227±0.057
Drepanocyte	0.078±0.032
Keratocyte	0.430±0.063
Stomatocyte	1.094±0.181
Acanthocyte	1.391±0.193
Echinocyte	4.117±0.350
Schizocyte	0.703±0.104

*The Mean value of each of the erythrocyte morphological abnormalities was compared with the scale in the reference guide given by Weiss (1984) and Constantino (2015) used for the evaluation of descriptive value and the clinical significance of the observed erythrocyte abnormalities

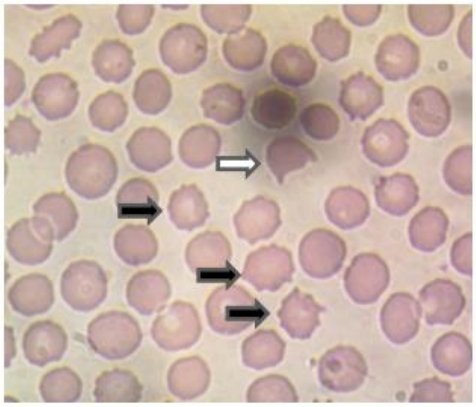

Figure 1: Giemsa stained dog red blood cell showing ecchinocyte (black arrow) and schizocyte (white arrow) (×100)

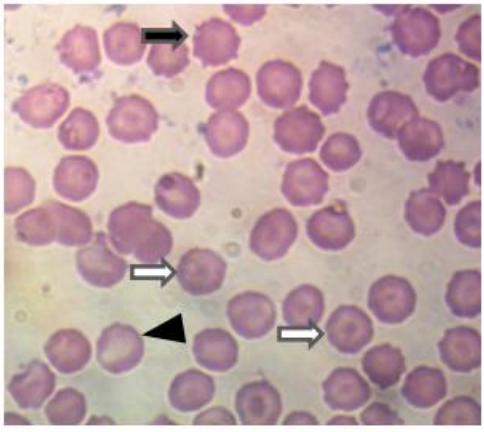

Figure 2: Giemsa stained dog red blood cells showing some ecchinocyte (black arrow), codocytes (white arrow) and stomatocyte (black arrowhead) (×100)

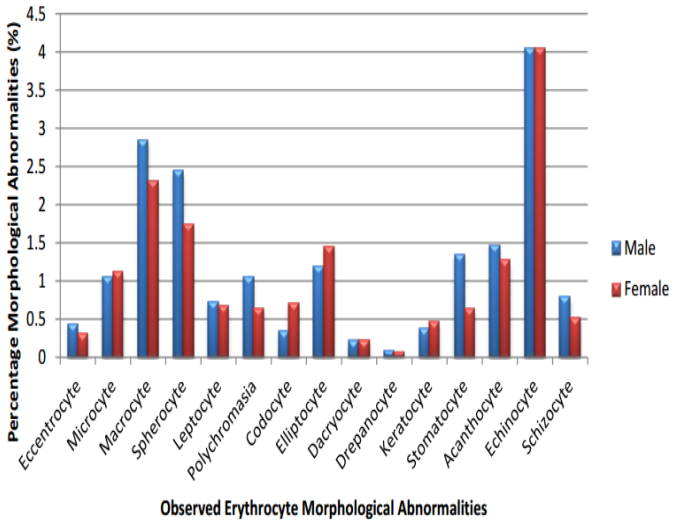

Figure 3. Graphical Representation of the Observed Erythrocyte Morphological Abnormalities in Male and Female Dogs.

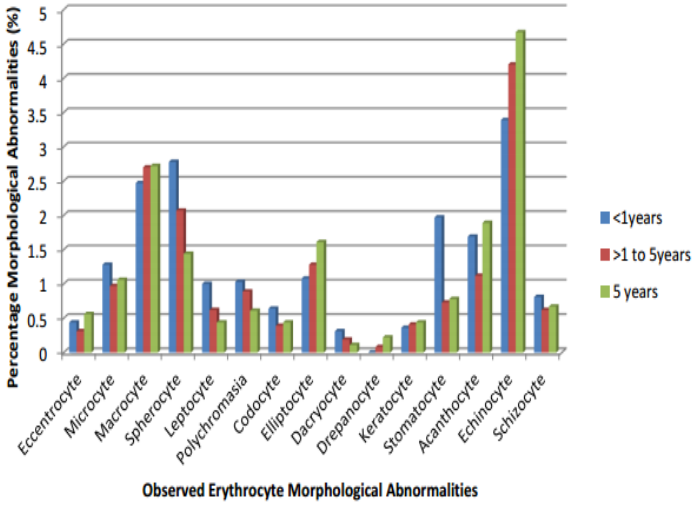

Figure 4. Graphical Representation of the Observed Morphological Abnormalities in the Different Age Groups.

As shown above, Figure 3 gives the graphical representation of the observed erythrocyte morphological abnormalities in male and female dogs while Figure 4 gives the graphical representation of the observed morphological abnormalities across the different age groups. The erythrocyte morphological abnormalities of the dogs in the different age group and sex are both not clinically significant and do not indicate any pathological state when evaluated using the reference guide by Weiss (1984).

As shown in table 5, the percentage erythrocyte morphological abnormalities across the different breed s were expressed in Mean ± S.E.M. compared to the scale by Weiss (1984), all the values were within the normal range for healthy dogs. The table also shows the different in the percentage of the erythrocyte morphological abnormalities across the different breeds.

Table 5. The Numerical Quantification of the Percentage Observed Erythrocyte Morphological Abnormalities in The Different Study Dog Breeds

Source of Variations	Breed				
	Als (n=25)	Rott (n = 8)	Boer (n = 9)	Local (n =15)	Others (n =7)
Eccentrocyte	0.30±0.09	0.63±0.18	0.39±0.18	0.43±0.15	0.29±0.29
Microcyte	1.04±0.23	1.25±0.35	1.50±0.51	0.97±0.26	0.64±0.32
Macrocyte	2.94±0.41	3.56±0.57	2.72±0.53	1.67±0.36	2.50±0.42
Spherocyte	1.78±0.28	1.56±0.68	2.67±0.51	2.37±0.41	3.29±2.16
Leptocyte	0.56±0.16	0.63±0.26	0.61±0.34	1.10±0.36	0.57±0.38
Polychromasia	0.84±0.20	0.44±0.22	1.39±0.33	0.83±0.22	1.07±0.38
Codocyte	0.26±0.10	0.81±0.39	0.61±0.36	0.53±0.30	0.50±0.36
Elliptocyte	1.48±0.20	1.44±0.32	0.78±0.33	1.27±0.25	1.00±0.38
Dacryocyte	0.22±0.10	0.13±0.08	0.00±0.00	0.43±0.16	0.07±0.07
Drepanocyte	0.06±0.04	0.00±0.00	0.17±0.12	0.07±0.07	0.14±0.14
Keratocyte	0.50±0.11	0.13±0.08	0.11±0.07	0.57±0.17	0.36±0.24
Stomatocyte	0.70±0.21	1.00±0.47	1.44±0.48	1.93±0.54	0.29±0.15
Acanthocyte	1.16±0.23	0.94±0.42	2.11±0.90	1.77±0.43	1.00±0.29
Echinocyte	4.40±0.57	3.13±0.63	4.44±1.29	3.77±0.61	3.86±1.02
Schizocyte	0.68±0.19	0.56±0.29	0.50±0.19	0.87±0.25	0.64±0.28

DISCUSSION

The present study has shown a significant difference in some haematological values (RBC, MCV, MCH, WBC, HB, PCV, Platelet count, Neutrophil count, Monocyte count, Eosinophil count and Basophil count) when compared with the reference values from laboratories in temperate regions that are commonly used for evaluation of haematological parameters in our laboratory. This is similar to earlier reports in which the haematological parameters of dog raised in the tropics were comparatively lower than those raised in the temperate region (Bush, 1991; Awah and Nottidge, 1998; Ariyibi et al., 2002). The disparity in the values of the haematological parameters of this animal can be adduced to the significant influence of the environment in the determination of the physiological state and parameters of animals (Etim et al., 2014). The significant influence of the environmental factors (which encompasses factors such as altitude, climate, nutrition etc.) has been studied extensively in human and animals and serves as an important basis for the observed differences (Etim et al., 2014).

The comparative difference seen in the erythrocyte parameters of the male and female dogs is also similar to previous reports in dogs (Ariyibi 2002) and goats (Tibbo et al., 2004). The relatively higher lecucocytic parameter values also seen in the female compared to the male is similar to reports in other studies (Ariyibi 2002, Tibbo et al., 2004) and this has been adduced to different physiological factors associated with the oestrus cycle in females (Tibbo et al., 2004; Mshelia et al., 2005).

From this study, the most common erythrocyte morphological abnormality was echinocytes (Figure 1 and Figure 2). This erythrocyte morphological abnormality has been associated with different factors such as artifactual changes thus buttressing the importance of proper sample collection, prompt and proper sample analysis in order to achieve good smear production devoid of artifacts (Harvey, 2012). This study finding cannot however be completely attributed to be due to artifactual changes since lithium heparin were used for the sample collection thus reducing the possibility of the crenation inducing effects of EDTA (ethylene diamine tetra-acetate) anticoagulant which is known to cause significant preanalytical crenation and echinocyte formation (Lippi et al., 2005; Gorrol and Mulley, 2009) and proper precautions were taken in the smear preparation.

Spherocytes and macrocytes were the next most commonly observed morphological changes which may be due to the need for a rapid turnover of the red cell as well as need for prompt regeneration of red cell possibly associated with haemoprotozoan (both subclinical and clinical manifestation) which are enzootic in this area (FAO, 1983). Other observed abnormalities include polychromasia, and schisocytes which could also be associated with the enzootic haemoprotozoan diseases (Telford et al., 1997). While however these erythrocyte morphological abnormalities were seen prominently, the relative count of these abnormalities when converted using the numerical reference guide were all not significant and

as such cannot be adduced to any pathological condition or disease state (Jones.2009; Constantino, 2015). This is important as it complements the clinical evaluation of the apparently clinically healthy status of the dogs used for this study and the credibility of the fact that the deviation of the haematological parameters seen are not due to associated pathologies.

This study was able to establish a haematological baseline and the associated morphological changes observed in blood of apparently healthy dogs raised in Ibadan, South-western Nigeria. The discrepancies in the range of parameters may be due to the influence of environmental factors on the physiological parameters. Therefore, the baseline obtained from these dogs could be used for interpretation of laboratory data in dogs raised in Ibadan and the significant difference between the haematological parameters of animals gives more credence to the importance of developing a working reference range for dogs raised in our tropical region.

More so, the qualitative examination of the morphological changes when compared with the quantitative evaluation of the haematological parameters can also be employed as an important diagnostic tool in canine practice.

REFERENCES

Aderemi, F.A. (2004): Effects of replacement of wheat bran with cassava root sievate supplemented or unsupplemented with enzyme on the haematology and serum biochemistry of pullet chicks. Trop. J. Anim. Sci., 7:147 - 153.

Ariyibi, A.A, Oyeyemi M.O, Ajadi R.A (2002): A Comparative Study of Some Hematology and Biochemical Parameters of Clinically Healthy Alsatian and Local Dogs. Afr. J. Biomed. Res. Vol. 5; 145 - 147

Awah and Nottidge, H.O (1998): Serum biochemical Parameters in Clinically Healthy Dogs in Ibadan. Trop. Vet. 16: 123-129.

Barger, A. M. (2010), "Erythrocyte morphology," in Schalm's Veterinary Hematology, Wiley-Blackwell, Ames, Iowa, USA, 6th edition, 2010, pp. 144-151.

Bush, B.M. (1991): Interpretation of Laboratory Results for small animal. Clinician Blackwell Scientific Publication, London.

Chien, S. (1987). Red cell deformability and its relevance to blood flow. Annu. Rev. Physiol. 49:177-192.

Coles, E.H. (1986): Veterinary Clinical Pathology. 4th Edition. W.B. Saunders Co. Philadelphia; 1986:10-360-70

Constantino, B. T. (2015). Reporting and grading of abnormal red blood cell morphology. John Wiley & Sons Ltd, Int. Jnl. Lab. Hem. 2015, 37, 1-7 doi:10.1111/ijlh.12215

Cork, S.C. and Halliwell, R.W. (2002): The Veterinary laboratory and Field Manual. In: Spector, W.S. (Ed.), Handbook of Biological Data. Nottinghman University Press, U.K; Saunders, Philadelphia, Pennsylvania, 302 -314

Doyle, D. (2006). William Hawson (1739 - 74): The father of haematology. Br. J. haematology, 133:375 - 381.

Etim N.N., Williams, M.E., Akpabio, U., and Offion E.E.A. (2014). Haematological Parameters and Factors Affecting their Values; Agricultural Science Volume 2, Issue 1 (2014), 37 - 47;

F.A.O (1983). F.A.O Animal Production and Health Paper 36: Ticks and Ticks - borne diseases selected articles from the WORLD ANIMAL REVIEW

Ginsbury, G.S. and Haga, S.B. (2006). Translating genomic biomarkers into clinically useful diagnostic. Experimental review on molecular diagnostic, 6: 179 – 191

Gorrol, A.H and Mulley, A.G (2009). Primary Care Medicine: Office Evaluation and Management of the Adult Patient. 6th ed. Lippincott Williams & Wilkins, Philadelphia. Pp. 629 – 630

Harvey, J.W. (2012). Veterinary Hematology: A Diagnostic Guide and Color Atlas. St. Louis, Mo, Elsevier/Saunders, 11 – 98

Jain, N.C (1993). Essentials of Veterinary Hematology. Lea & Febiger, Philadelphia, U.S,A

Jones K.W. (2009). Evaluation of cell morphology and introduction to platelet and white blood cell morphology. In. Denise Harmening (2009). Clinical haematology and fundamentals of hemostasis. Philadelphia PA; FA. Davis Co., 2009 5th edition

Kaplan, L. et al (2003): Clinical chemistry Theory, Analysis, Correlation, ed 2. Mosby, St. Louis, 2003, p 686.

Khan, T. A. and Zafar, F. (2005). Haematological study in response to various doses of oestrogen in broiler production. Int. J. Poult. Sci., 40 (10): 748 – 751.

Kumar et al., (2005). Robbins and Cotran Pathologic Basis of Disease 7th ed. (2005), Editors: Kumar, Abbas & Fausto. Elsevier and Saunders publishers

Lippi, G., Bassi A., Giorgio B., Montagnana M., Salvagno G.L. & Guidi G.C (2005). Pre – analytical error tracking in a laboratory medicine department; Result of a 1 - year experience. Clin. Chem 52: 1442 – 1443

Mshelia, G.D, Amin, J.D and Chaudhari, S.U.R (2005). Haemogram of a Nigerian Mongrel Bitch at different stages of the reproductive cycle. Pakistan Vet. J., 25(1).

Olayemi, F.O., Azeez, I.O., Ogunyemi, A., Ighagbon, F.O (2009). Study On Erythrocyte Values of the

Nigerian Indigenous Dog. FOLIA VETERINARIA, 53, 2: 65-67.

Omamegbe, J.O. and Uche, U.E. (1985). Haemogram studies in Nigerian local dogs suffering from Ancylostomiasis, Babesiosis and Trypanosomiasis. Bull. Anim. Health Prod. Afri. 33: 335-338.

Piccione, G., Casella, S., Lutri, L., Vazzana, I., Ferrantelli, V., and Caola, G. (2010). Reference values for some haematological, haematochemical and electrophoretic parameters in the Girgentana goat. Turk. J. Vet. Anim. Sci. 2010; 34(2): 197-204

Sastry, G.A. (1985). Veterinary Clinical Pathology. 4th ed. New Delhi, India: CBS; 1985:1-32. Telford, S.R., and Spielman, A. (1997). Babesiosis of humans, p. 349-359. In F. E. G. Cox, J. P. Kreier, and D. Wakelin (ed.), Topley and Wilson's Microbiology and Microbial Infections, 9th ed. Arnold, London, England.

Tibbo, M., Jibril, Y., Woldemeskel, M., Dawo, F., Aragaw, K., and Rege, J.E.O. (2004). Factors Affecting Hematological Profiles in Three Ethiopian Indigenous Goat Breeds. Intern J Appl Res Vet Med, Vol. 2, No.4

Walton, J.R. (1973). Uniform grading of hematologic abnormalities. Am J Med Technol 1973;39: 517409 23.

Weiss, D.J. (1984). Uniform evaluation and semiquantitative reporting of hematologic data in veterinary laboratories. Vet Clin Pathol. 1984; 13:27-31.

Weiss, D.J., Wardrop, K.J. and Schalm, O.W. (2010). Schalm's Veterinary Haeamtology. Ames, Iowa, Wiley - Blackwell