



Haemato-biochemical studies of dogs with haemorrhage-induced dehydration

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Abstract

Factors that contribute to water loss in tropical animals are complex and constantly changing. To evaluate the haemato-biochemical parameters of dogs with haemorrhage-induced dehydration. A total of 12 dogs were used; haemorrhage was induced by daily removal of 10 ml of blood over a period of 28 days and analysed at the Department of Veterinary Pathology, Ahmadu Bello University (A.B.U.), Zaria, Nigeria. Dehydration was clinically assessed. Age, sex, body weight and generalised body condition of the animals were determined. Whole blood was collected for determination of haematological parameters. Serum was prepared from whole blood to determine the concentrations of urea, creatinine, total protein, albumin, glucose, sodium, calcium, chloride, phosphorus, potassium, bicarbonate, blood urea nitrogen (BUN)/creatinine ratio and anion gap (AG) as well as serum activities of liver enzymes. Reductions in body weight (1.67 kg, 2.17 kg and 3.17 kg) due to degrees of dehydration were observed on days 14, 21 and 28. Significantly higher values of packed cell volume and haemoglobin concentration ($P < 0.01$) due to dehydration was observed between days 0 and 14, also between days 0 and 28. Higher concentrations of urea, creatinine ($P < 0.01$), BUN/creatinine, total protein, albumin and urine specific gravity ($P < 0.05$) were observed between day 0 and days 14, 21 and 28. This study is the first to report the haemato-biochemical changes of Nigerian local dogs with haemorrhage-induced dehydration. The study did not investigate the role of type of diet on dehydration, and it is recommended that future studies should be carried out to elucidate this.

Keywords Dehydration · Dogs · Haemorrhage · Total body weight

Introduction

Dehydration which is defined as the depletion of the whole body fluid is the most common form of fatal hypovolemic shock in dogs. Dehydration may be isonatremic, hyponatremic or hypernatremic depending upon the changes in serum osmolarity. Change in weight is the primary

marker for determining the severity of dehydration (Davis et al. 2013). Blood volume of normal dogs is expressed in terms of percentage body weight, and this represents 7% of body weight equivalent to about 70 ml/kg of the total body weight. However, the total body weight varies considerably with age, sex and breed, and the total body fluid compartment which changes throughout life may be severely affected by pathologic conditions (Wamberg et al. 2002) such as dehydration. The total body water content of dogs is about 70% of body weight (Kasuya et al. 2003). Physical findings associated with fluid losses of 5 to 15% of body weight vary from no clinically detectable changes (Armstrong et al. 2012) to signs of hypovolemic shock which could occur due to fluid loss resulting to multiple organ failure due to low tissue perfusion (Prittie 2004; DiBartola and Bateman 2006; Wilson and Morley 2008).

The change in body weight is an effective and easy method of dehydration assessment especially for measuring dehydration that occurs over a period of time (Kolasa et al. 2009), and the percentage loss of body weight equals percentage loss of

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body water and hence, percentage dehydration (Esiebo 2017). Therefore, an accurate weight determination is requisite to dehydration assessment using body weight.

Haemorrhage is a medical emergency that is commonly encountered by physicians in emergency, operating and intensive care units. Significant loss of intra-vascular volume may lead to hemodynamic instability, decreased tissue perfusion, cellular hypoxia, organ damage and death (Davis et al. 2013). Nigerian local dogs are dogs native to Nigeria with an adult dog weighing between 15 and 25 kg. They are dolichocephalic dogs with an omnivorous feeding pattern due to their high degree of domestication (Igado 2011). Even though, haemorrhage-induced dehydration has been reported in dogs (Boer 1946), there is dearth of information on haemato-biochemical profiles of Nigerian local dogs with haemorrhage-induced dehydration. Hence, the aim of this study was to determine the haemato-biochemical profiles of Nigerian local dogs with haemorrhage-induced dehydration.

Materials and methods

The study area

The study was conducted at the Veterinary Teaching Hospital and Faculty of Veterinary Medicine, Ahmadu Bello University, Samaru, Zaria, Kaduna state, Nigeria. Zaria lies in the Guinea Savannah belt, located at 2200 ft above sea level within latitudes 11° 7', 11° 12' N and longitude 7° 41' E with a mean annual temperature of 27 °C. Zaria experiences distinct wet and dry seasons. (Abdulhamid et al. 2016).

Experimental animals and study design

A total of five female and seven male Nigeria local dogs identified morphologically were sampled in this study. The experimental dogs aged between 12 and 24 months were housed in the dog kennel of the Veterinary teaching hospital, Ahmadu Bello University (A.B.U.), Zaria. This study was approved by the A.B.U. Research and Ethics Committee and was conducted according to international guidelines (Wolfensohn and Lloyd 2013). All institutional and national guidelines for the care and use of laboratory animals were followed. The dogs were dewormed and treated upon arrival for external parasite. They were acclimatised for 14 days prior to sampling. The dogs were fed a home-prepared diet according to the recommendation of NRC (2006), and drinking water was provided ad libitum throughout the duration of this study. Haemorrhage was induced by daily removal of 10 ml of blood over a period of 28 days. The dogs were sampled on days 0, 14, 21 and 28.

Assessment of body weight, percentage dehydration and general body condition

Weight was determined using conventional procedures (Wosu 2002); percentage dehydration was assessed as described by Davis et al. (2013) while the body condition scores were evaluated as previously described (Laflamme 1997).

Blood sample collection

Blood samples for the haematological and serum biochemical determinations were collected from the cephalic vein of each dog using needle and syringe. These samples were collected between the hours of 8 and 10 a.m. Blood samples (1 ml) for haematology were dispensed into sample bottles containing ethylene diamine tetra acetic acid (1 mg/ml of blood). For serum biochemical analysis, 4 ml of blood was emptied into plain tubes and sera harvested within an hour after centrifuging the clotted blood with at 3000 rpm for 15 min. The haematological and serum biochemical analyses were carried out immediately after sample collection.

Determination of haematological parameters

Packed cell volume (PCV) was determined by the micro-haematocrit method (Thrall and Weiser 2002); haemoglobin concentration (Hbc) was determined by the cyanomethaemoglobin method (Higgins et al. 2008). Red blood cell (RBC) count and total leukocyte count (TLC) were carried out by the haemocytometry method (Thrall and Weiser 2002); differential leukocyte count was done by making a blood smear on a clean glass slide and staining using Leishman technique. The different cell types were enumerated as described (Thrall and Weiser 2002). The mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were calculated using the standard formulae (Coles 1980).

Determination of biochemical changes

Concentrations of creatinine, urea, total protein, albumin, glucose and electrolytes such as sodium (Na^+), potassium (K^+), chloride (Cl^-), calcium (Ca^{2+}), phosphate (PO_4), bicarbonate (HCO_3^-), aspartate amino transferase (AST), alanine amino transferase (ALT) and alkaline phosphatase (ALP) in the serum were measured using commercial test kits (Agappe, India) by means of an ultraviolet digital spectrophotometer (Perkin Elmer AAS 400). Blood urea nitrogen/creatinine ratio (BUN/Cr) and anion gap were calculated using the as previously described (George 1994).

Table 1 Dehydration assessment of dogs on days 0, 14, 21 and 28

Days of sampling	Physical examination findings*	Percentage dehydration (%)*	Degree of dehydration*	Number of dogs involved
Day 0	• Normal (euhydrated)	0	Normal	12
Day 14	• Minimal loss of skin turgor • Semidry mucous membrane • Normal eye	5	Mild	12
Day 21	• Minimal loss of skin turgor • Semidry mucous membrane • Normal eye	5	Mild	12
Day 28	• Moderate loss of skin turgor • Dry mucous membranes • Enophthalmos	8	Moderate	12

*Davis et al. 2013

Statistical analysis

Data from the study was computed as mean $\pm$ SEM and analysed using ANOVA (analysis of variance). Significance was accepted for values of $P < 0.05$ with a 95% confidence interval.

Results

Dehydration assessment

Table 1 shows the dehydration assessment of experimental dogs according to Davis et al. (2013) on days 0, 14, 21 and 28.

Body weight and percentage body weight loss

Figure 1 and Table 2 show the body weight and percentage loss of experimental dogs on days 0, 14, 21 and 28. Lower body weights were recorded on days 14, 21 and 28. There was significant difference in body weights ($P < 0.05$) observed on days 0 and 28. However, no differences ($P > 0.05$) were observed between days 0 and 14 and also between days 0 and 21.

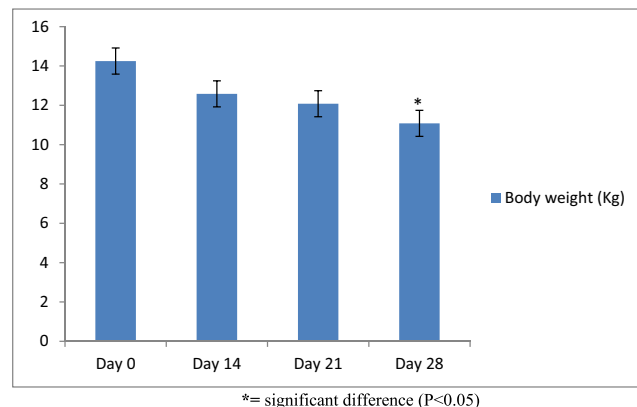


Fig. 1 Mean ($\pm$ SEM) body weight of experimental dogs on days 0, 14, 21 and 28 respectively.*Significant difference ($P < 0.05$)

Haematologic findings

Table 3 shows the mean ($\pm$ SEM) haematologic parameters of experimental dogs on days 0, 14, 21 and 28. Day 14 observation has higher value of PCV and haemoglobin concentration compared to other days. There was no significant ($P > 0.05$) difference in PCV and Hb between days 0 and 21. However, there were significant ($P < 0.01$) differences between days 0 and 14, also between days 0 and 28. The mean values of RBC and MCHC of the dogs on all days were comparable ($P > 0.05$). However, there was significant difference ($P < 0.05$) in mean values of MCV between days 0 and 28. Meanwhile, the mean value of total and differential leucocyte counts on all sampling days did not differ significantly ($P > 0.05$).

Serum biochemical changes

Figures 2 and 3 show the serum metabolites changes. There were significant differences in the serum levels of blood urea nitrogen (BUN), creatinine ($P < 0.01$), blood urea nitrogen/creatinine ratio (BUN/Cr) ($P < 0.05$) (Fig. 2), and also in the levels of total protein and albumin ($P < 0.05$) between days 0 and all other days of sampling (14, 21 and 28) (Fig. 3). Other changes in biochemical parameters: electrolyte profiles, liver enzyme activities, and some urinary indices are presented

Table 2 Loss of body weight and percentage loss of body weight of dogs on days 0, 14, 21 and 28

	Loss of body weight (Kg)	Percentage loss of body weight (%)
Days 0 to 14	1.67	11.72
Days 0 to 21	2.17	15.23
Days 0 to 28	3.17	22.25

Table 3 Haematologic parameters (mean $\pm$ SEM) of dogs on day 0, 14, 21 and 28 ($N=12$)

Parameters	Day 0	Day 14	Day 21	Day 28	Normal range*
PCV (%)	36.92 $\pm$ 1.55 ^a (30.0–46.0)	45.00 $\pm$ 2.52 ^b (34.0–61.0)	39.50 $\pm$ 1.78 ^a (30.0–53.0)	30.83 $\pm$ 1.71 ^a (20.0–42.0)	37–55
Haemoglobin (g/dl)	12.40 $\pm$ 0.59 ^a (11.0–15.9)	14.41 $\pm$ 0.90 ^b (10.2–20.0)	13.28 $\pm$ 0.41 ^a (11.3–16.2)	10.27 $\pm$ 0.56 ^a (6.8–14.1)	12.0–18.0
RBC count ($\times 10^3/\mu\text{l}$)	5.30 $\pm$ 0.187 ^a (4.3–6.2)	6.15 $\pm$ 0.394 ^b (4.4–10.0)	6.38 $\pm$ 0.335 ^a (4.9–9.0)	4.75 $\pm$ 0.284 ^a (3.0–6.4)	5.5–8.5
MCV (fl)	69.57 $\pm$ 0.95 ^a (64.2–75.0)	67.75 $\pm$ 2.34 ^a (50.0–82.6)	67.86 $\pm$ 1.71 ^a (57.9–79.4)	59.23 $\pm$ 1.69 ^b (56.3–78.0)	60.0–77.0
MCHC (mg/dl)	33.03 $\pm$ 0.431 ^a (29.4–35.0)	33.13 $\pm$ 0.208 ^a (31.9–34.3)	33.23 $\pm$ 0.285 ^a (31.9–35.7)	32.18 $\pm$ 0.336 ^a (30.5–34.0)	33.0–36.0
Leucocytes ($\times 10^3/\mu\text{l}$)	10.62 $\pm$ 0.66 ^a (8.0–14.0)	17.83 $\pm$ 1.82 ^a (7.0–26.5)	14.97 $\pm$ 1.90 ^a (7.7–28.0)	17.9 $\pm$ 4.32 ^a (3.8–48.4)	6.0–17.0
Neutrophils ($\times 10^3/\mu\text{l}$)	7.19 $\pm$ 0.10 ^a (2.5–14.5)	12.87 $\pm$ 1.68 ^a (5.4–23.3)	11.65 $\pm$ 1.57 ^a (6.11–22.0)	14.56 $\pm$ 3.92 ^a (1.18–46.0)	3.0–11.5
Lymphocytes ($\times 10^3/\mu\text{l}$)	2.35 $\pm$ 0.33 ^a (0.4–4.9)	1.63 $\pm$ 0.49 ^a (0.1–6.3)	1.077 $\pm$ 0.21 ^a (0.1–2.4)	1.077 $\pm$ 0.21 ^a (0.1–2.4)	1.0–4.8
Eosinophils ($\times 10^3/\mu\text{l}$)	0.359 $\pm$ 0.14 ^a (0.0–1.7)	0.172 $\pm$ 0.08 ^a (0.0–1.0)	0.718 $\pm$ 0.33 ^a (0.0–3.5)	0.219 $\pm$ 0.13 ^a (0.0–1.3)	0–1.3
Monocytes ($\times 10^3/\mu\text{l}$)	0.504 $\pm$ 0.12 ^a (0.0–1.4)	1.576 $\pm$ 0.33 ^b (0.6–4.3)	0.701 $\pm$ 0.15 ^a (0.0–1.6)	0.707 $\pm$ 0.20 ^a (0.0–2.0)	0.1–1.4
Basophils ($\times 10^3/\mu\text{l}$)	0.00 $\pm$ 0.00 ^a (0.0–0.0)	0.00 $\pm$ 0.00 ^a (0.0–0.0)	0.02 $\pm$ 0.02 ^a (0.0–0.2)	0.00 $\pm$ 0.00 ^a (0.0–0.0)	0–0.1

Values in brackets are ranges, n = number, *Saror et al. 1979; Ihedioha et al. 2013, g/dl grams per deciliter, $\times$ multiplication sign, μl per micro litre. Values in rows with the same superscripts are comparable ($P > 0.05$). Values in rows with the different superscripts are significantly different ($P < 0.05$)

in Tables 4, 5, and 6. The mean concentrations of Na^+ , K^+ , Ca^{2+} , Cl^- , P , HCO_3^- and anion gap did not differ significantly ($P > 0.05$) (Table 4). Also, the differences in the mean activities of AST, ALT and ALP in the dogs were not significantly different ($P > 0.05$) (Table 5). There was significant ($P < 0.05$) difference in mean urine specific gravity between day 0 and all other days of sampling, but there was no significant ($P > 0.05$) difference in urine pH of the dogs (Table 6).

Discussions

On day 0, the dogs were clinically assessed to be normal based on the absence of clinical signs suggestive of dehydration (Davis et al. 2013) and also, all clinico-pathological parameters evaluated were within normal range and were used as control to compare the observation on the other days of sampling (days 14, 21 and 28). The values agreed with the works of Saror et al. (1979) and Ihedioha et al. (2013); therefore,

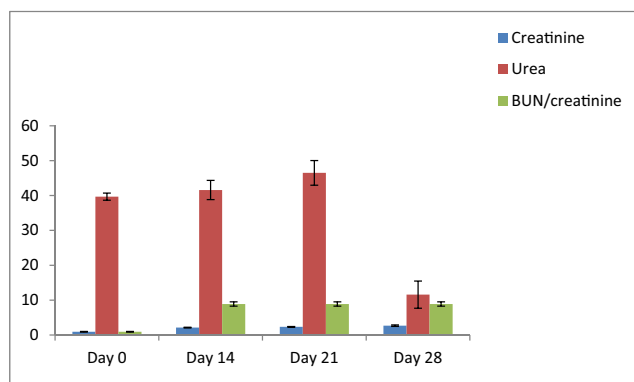


Fig. 2 Creatinine, urea and BUN/creatinine ratio of dogs on days 0, 14, 21 and 28

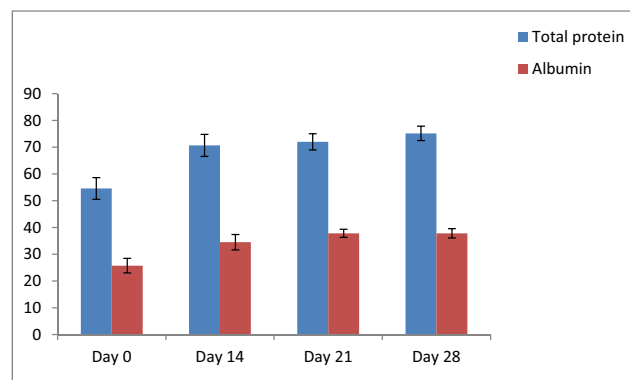


Fig. 3 Total protein and albumin concentration in normal (day 0) and dehydrated (days 14, 21, and 28) dogs in group B examined at ABUVTH, Zaria

Table 4 Serum electrolyte concentrations (mean $\pm$ SEM) on days 0, 14, 21 and 28 ($N = 12$)

Parameters	Day 0	Day 14	Day 21	Day 28	Normal range*
Na ⁺ (mmol/l)	140.3 $\pm$ 2.125 ^a (128–150)	140.3 $\pm$ 1.652 ^a (128–150)	142.8 $\pm$ 2.129 ^a (132–156)	143.3 $\pm$ 1.591 ^a (135–154)	142–152
K ⁺ (mmol/l)	4.608 $\pm$ 0.158 ^a (3.4–5.2)	4.808 $\pm$ 0.122 ^a (4.2–5.8)	4.483 $\pm$ 0.284 ^a (3.0–5.9)	4.017 $\pm$ 0.198 ^a (3.1–5.2)	3.9–5.1
Ca ²⁺ (mg/dl)	9.675 $\pm$ 0.194 ^a (8.3–10.7)	9.375 $\pm$ 0.260 ^a (7.9–10.6)	10.28 $\pm$ 0.314 ^a (8.5–12.1)	9.783 $\pm$ 0.331 ^a (7.5–11.2)	9.1–11.7
Cl ⁻ (mg/dl)	113.5 $\pm$ 2.065 ^a (100–124)	113.0 $\pm$ 1.665 ^a (100–124)	116.3 $\pm$ 2.703 ^a (102–138)	114.8 $\pm$ 3.241 ^a (98–136)	110–124
P (mg/dl)	4.208 $\pm$ 0.494 ^a (2.3–8.8)	5.117 $\pm$ 0.549 ^a (3.4–9.9)	5.108 $\pm$ 0.706 ^a (3.1–11.0)	3.975 $\pm$ 0.364 ^a (2.8–7.2)	2.9–5.3
HCO ₃ ⁻ (mmol/l)	21.67 $\pm$ 1.310 ^a (16.0–31.0)	21.58 $\pm$ 0.957 ^a (17.0–28.0)	21.00 $\pm$ 1.398 ^a (14.0–32.0)	21.50 $\pm$ 0.774 ^a (18.0–26.0)	17–24
Anion gap (AG) (mEq/L)	9.69 $\pm$ 3.904 ^a (3.4–9.9)	10.48 $\pm$ 2.239 ^a (–6.3–17.7)	9.98 $\pm$ 2.275 ^a (5.8–23.6)	11.02 $\pm$ 3.157 ^a (–10.9–25.6)	8–25

Values in brackets are ranges, n = number, *Ihedioha et al. 2013, mg/dl milligramme per decilitre, g/l gram per litre and mmol/l milli-molar per litre. Values in rows with the same superscripts are comparable ($P > 0.05$)

Values in rows with the different superscripts are significant ($P < 0.05$)

these values could serve as reference value of haematology, clinical biochemistry and urinalysis in local dogs Nigeria.

Decrease in body weight is an effective and easy method of dehydration assessment especially for measuring dehydration over a period of time (Kolasa et al. 2009). The observed loss of body weight which corresponds to loss of total body water and hence percentage dehydration was found to be consistent throughout the sampling period. The observed body weight losses were 1.7 kg, 2.2 kg and 3.2 kg between days 0 and 14, days 14 and 21 and days 21 and 28 respectively which correspond with the degrees of dehydration 12, 15 and 22. The values are being proposed to be the true percentage dehydration in this dogs, since percentage loss in body weight is said to be equal to total body water loss and hence, percentage dehydration (George 1994; Esievo 2017). This result is supported by a study which compared the body weight of mice provided water ad libitum to those exposed to experimental water deprivation for 3 days; the dehydrated mice lost an average of 23.2% body

weight and appeared active with normal appetite. It was, thus, concluded that the amount of weight loss did not depend on daily water intake (Kordonowy et al. 2017).

Type of diet could be a contributing factor resulting in the levels of dehydration in the dogs under study as these dogs were fed home-made food and restaurant left-over which usually have low water content and high fat content; it should be noted that dogs are carnivores that are expected to be fed with fleshy meat (and bones) that has high moisture content (Esievo 2017). The effect of diet on haematology, clinical biochemistry, and live and relative organ weight in albino rat was well described by Aka et al. (2009).

The findings in this study of significantly higher mean packed cell volume and concentrations of haemoglobin, total plasma protein, albumin, urea, creatinine and blood urea nitrogen/creatinine ratio in the dehydrated dogs (days 14, 21 and 28) compared to normal (day 0) dogs agree with previous report (Armstrong et al. 2016). The observation coupled with

Table 5 Serum liver enzyme activities (mean $\pm$ SEM) on days 0, 14, 21 and 28 ($N = 12$)

Parameters	Day 0	Day 14	Day 21	Day 28	Reference values*
Aspartate amino transferase (U/l)	12.17 $\pm$ 0.737 ^a (8.0–16.0)	13.08 $\pm$ 1.003 ^a (8.0–10.0)	13.33 $\pm$ 0.513 ^a (10.0–16.0)	13.08 $\pm$ 0.866 ^a (8.0–20.0)	5–55
Alanine amino transferase (U/l)	10.75 $\pm$ 1.533 ^a (4.0–20.0)	12.00 $\pm$ 0.628 ^a (4.0–20.0)	10.33 $\pm$ 1.789 ^a (4.0–25.0)	13.42 $\pm$ 3.322 ^a (5.0–48.0)	5–107
Alkaline phosphatase (U/l)	26.83 $\pm$ 6.742 ^a (8.0–71.0)	32.42 $\pm$ 5.984 ^a (8.0–74.0)	40.67 $\pm$ 5.612 ^a (6.0–71.0)	43.42 $\pm$ 10.51 ^a (10.0–113.0)	10–150

Values in brackets are ranges, U/l = unit per litre, n = number, *Sirois 1995

Values in rows with the same superscripts are comparable ($P > 0.05$)

Values in rows with the different superscripts are significant ($P < 0.05$)

Table 6 Specific gravity and pH of dogs on day 0, 14, 21 and 28

Parameters	Day 0	Day 14	Day 21	Day 28	Reference values*
Specific gravity	1.012 ± 0.002 ^a (1.005–1.025)	1.020 ± 0.002 ^b (1.010–1.030)	1.020 ± 0.002 ^b (1.010–1.030)	1.024 ± 0.002 ^b (1.015–1.030)	< 1.015
pH	6.750 ± 0.392 ^a (5.0–9.0)	6.917 ± 0.358 ^a (5.0–9.0)	6.833 ± 0.271 ^a (5.0–8.0)	7.500 ± 0.261 ^a (6.0–9.0)	7–9

Values in brackets are ranges, *n* = number, *Archer 2005

Values in rows with the same superscripts are comparable (*P* > 0.05)

Values in rows with the different superscripts are significant (*P* < 0.05)

the observed decreases in mean body weights of the dogs was highly suggestive of a causal role of dehydration induced by haemorrhage in the dogs under study.

The observed increase in PCV and haemoglobin concentration on day 14 was attributed to haemoconcentration, which had occurred consequent to dehydration. Similar findings have been reported by Useh et al. (2005) in dehydrated horses. Meanwhile, the abnormally lower values of PCV and haemoglobin concentration observed on day 28 was indicative of anaemia. This finding agrees with the work of Norman (2009). The microcytic hypochromic anaemia observed was due to chronic bleeding (haemorrhage) because chronic blood loss is usually associated with chronic haemoglobin and hence Fe²⁺ losses. Ihedioha et al. (2008) reported significantly lower erythrocytic indices indicative of microcytic hypochromic anaemia produced on the 15th day post-bleeding in albino rats. Besides the anaemia, all other clinico-pathologic findings points to dehydration; it is therefore pertinent to emphasise that the anaemic values observed are deceptive because it is in existence with dehydration. The explanation given for the normal PCV and haemoglobin concentration observed despite loss in body weight on day 21 was a slight increase in PCV due to dehydration as a result of fluid loss. Similar observation has been made by Panda (2006) in dehydrated dogs and Bhat et al. (2013) in a comparative study between healthy dogs and those suffering from enteritis. Normal values of total and differential leucocyte counts observed were suggestive of a normal leukogram indicating the absence of entities that could result in leukocytic alterations in the dogs.

Increased urea and creatinine concentration were observed in cases with established dehydration and in dogs without any trace of kidney pathology (during physical examination). Hence, these changes had only causal relationship with dehydration. Similar increases due to dehydration have been reported in pregnant camels (Fathi and Asiaban 2016) and in humans (Relles et al. 2013). The observation of a normal blood urea nitrogen (BUN)/creatinine (Cr) ratio in dehydrated dogs in this current study was in contrast with previous reports (Fortes et al. 2015; Lin et al. 2016). No explanation could be offered for the variation observed in this present study.

Increased total protein and albumin concentrations were observed due to dehydration as levels of albumin and total protein are increased in patients with a relative reduction in serum water as in dehydration (Levitt and Levitt 2016).

In this study, detailed urinalysis revealed that urine specific gravity increases were consistent with certain degrees of dehydration in all dehydrated groups. During dehydration with normal kidney function, urine becomes concentrated with a low urine output (volume) due to conservation of body water (Armstrong 2007). The finding of increased urine specific gravity as a result of dehydration agreed with a recent report (Cheuvront 2016) on aged patients. No observable difference was observed in the urine pH because changes in urinary pH are mainly determined by blood pH and blood pH is closely maintained within narrow limit.

In this present study, haemorrhage induced dehydration had no significant effect on the levels of sodium, calcium, chloride, potassium, phosphorus, bicarbonate and anion gap as well as the activities of ALT, AST and ALP.

In conclusion, this study is the first to report the haemato-biochemical changes in Nigerian dogs with haemorrhage-induced dehydration. Even though the type of diet may have impact on the levels of dehydration observed in this study, it was postulated that 22% body weight (or body water) loss, and hence 22% dehydration are compatible with life in Nigerian local dogs. Further studies should focus on the effect of type of diet on dehydration in dogs.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All applicable international, national, and/or institutional guidelines for the care and use of animals were followed.

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