Haematological and serum biochemistry profile of the juvenile wild African giant rat (*Cricetomys gambianus*, Waterhouse – 1840) in Nsukka, South-Eastern Nigeria – a preliminary investigation

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**ABSTRACT**

The study evaluated the haematological and serum biochemistry profile of juvenile wild African giant rat and determined the influence of sex on the haematological and serum biochemistry parameters. These evaluations were carried out on 18 juvenile wild African giant rats of either sex, in Nsukka, south-eastern Nigeria, within the months of March–May 2014. Standard procedures were carried out in all the haematological and serum biochemical determinations. The overall mean with the minimum and maximum values for some of the haemato-biochemical parameters were as follows: packed cell volume \(34.87 \pm 0.76\% (31.00 – 39.00)\); red blood cell count \(9.33 \pm 0.66 \times 10^{6}/\mu l (6.26 – 13.40)\); haemoglobin concentration \(10.27 \pm 0.22 \text{ g/dl} (9.26 – 12.63)\); total leukocyte count \(7.74 \pm 0.14 \times 10^{3}/\mu l (6.26 – 9.05)\); aspartate aminotransferase \(76.15 \pm 6.68 \text{ IU/L} (54.58 – 128.54)\); alanine aminotransferase \(18.09 \pm 1.61 \text{ IU/L} (11.91 – 25.49)\); alkaline phosphatase \(102.08 \pm 2.43 \text{ IU/L} (83.18 – 111.82)\); total proteins \(76.15 \pm 6.68 \text{ g/dl} (54.58 – 128.54)\); blood urea nitrogen \(10.27 \pm 0.22 \text{ g/dl} (9.26 – 12.63)\); total bilirubin \(76.15 \pm 6.68 \text{ IU/L} (54.58 – 128.54)\); alanine aminotransferase \(18.09 \pm 1.61 \text{ IU/L} (11.91 – 25.49)\); alkaline phosphatase \(102.08 \pm 2.43 \text{ IU/L} (83.18 – 111.82)\); total proteins \(4.70 \pm 0.10 \text{ g/dl} (4.03 – 5.18)\). The females had significantly higher \((p < 0.05)\) serum ALT, blood urea nitrogen and albumin values than males. The present study has presented preliminary information on the range of haematological and serum biochemistry parameters which may be useful to biomedical researchers and veterinary clinicians.

**1. Introduction**

The African giant rat (*Cricetomys gambianus*) also known as the Gambian pouched rat is a large murid, nocturnal and fossorial rodent. It is native to Africa and possesses very poor eyesight and depends on its sense of smell and hearing. Principally, the African giant rat lives in burrows of low oxygen concentration of 6% and high carbon dioxide of 3.8% and comes out at night in search for food (Ibe et al. 2011). The condition of the burrows may have an impact on the structural components of the cardiovascular and respiratory systems, haematology and blood chemistry parameters (Chapman & Bennet 1975). These rats are also found in forests, thickets, pits and bushes, although many thrive in urban and suburban settings (Cooper & Erlwanger 2007). The rat is known to be omnivorous as they feed on vegetables, insects, palm fruits and kernels and date palm. It also lives in burrows underground and weighs between 1 and 1.4 kg and reaches sexual maturity at 5–7 months of age in the wild. Trained Gambian pouched rats are useful in detecting land mines and tuberculosis with their highly developed sense of smell (Wood 2007), and also used as exotic pets (Cooper & Erlwanger 2007). In many African countries, they are valued as an important food item and a source of protein (Olayemi & Adezhina 2002).

Haematology and serum biochemical assessments are relevant tools in evaluating the physiological and pathological status of mammals and birds, as they provide information for the proper diagnosis of diseases, making a prognosis, evaluating the efficacy of instituted therapy, and toxicity of drugs and chemical substances (Stockham & Scott 2008). Serum biochemical assessment helps to predict pathological processes in the vital internal organs of the body such as the liver, muscle, heart, pancreas and kidney (Stockham & Scott 2008). It also helps to establish the presence or absence of disease of an organ, and determine the nature and extent of a disease process (static, progressive or regressive) by serial performance of laboratory tests of the internal organs. The haematological parameters of utmost clinical importance include the red blood cell (RBC) counts, packed cell volume (PCV), haemoglobin concentration (Hbc), mean corpuscular values, white blood cell counts and differential cell counts (Thrall & Weiser 2002). The serum biochemistry parameters of great relevance include serum enzyme tests (aspartate aminotransferase (AST), alanine aminotransferase (ALT) and alkaline phosphatase (ALP)), total bilirubin, cholesterol, total proteins, albumin, globulin, blood urea nitrogen (BUN) and creatinine (Stockham & Scott 2008).

Several physiological factors have been known to affect the haematological and serum biochemistry parameters in appar-
ently healthy rats. These factors are breed, sex, age, reproductive status; time of feeding, diurnal variations, nutritional state and management; and geographical/climatic factors such as temperature, humidity, altitude and day length (Weiss & Wardrop 2010). Alterations in haematological and serum biochemistry values can be attributed to poor sample handling, stress during blood sample collection, blood sampling techniques, presence of an inhibitor such as anticoagulant and stress of capture (Stockham & Scott 2008).

In available literature, there are reasonable amount of haematological and serum biochemistry values of rodents such as the birch mouse (Wolk 1985), juvenile laboratory rat (Ihedioha et al. 2004), African soft-furred rat (Kagira et al. 2005), wild grasscutter (Opara et al. 2006) and adult wild African giant rat (C. gambianus) (Oyewale et al. 1998a, 1998b; Olayemi & Adeshina 2002; Cooper & Erlwanger 2007), but only little information is available on the haematology and serum biochemistry values of the juvenile wild African giant rat (Nssien et al. 2002; Onwuka et al. 2003). Due to the variations in the haematological and serum biochemistry values, there is need for each clinic to establish its own reference range of values for relevant animal population. Also, due to the popularity of this rodent, efforts have been made to domesticate and keep them as pet, and attempts have also been made to use them as laboratory animals (Olayemi & Adeshina 2002), hence the need to establish reference range of values for the juvenile wild African giant rat. Therefore, this present study is a preliminary attempt of establishment of a range of haematological and serum biochemistry parameters of the juvenile wild African giant rat in Nsukka metropolis, south-eastern Nigeria.

2. Materials and methods

2.1. Animals for the study

The rats used for this study were 18 juvenile African giant rats, comprising 8 males and 10 females. They were captured between March and May 2014 (early rainy season), by setting traps in bushes, thickets and near drainage pits within the Nsukka metropolis, south-eastern Nigeria; transported back to the Animal house, Department of Veterinary Anatomy, University of Nigeria, Nsukka; and kept in groups of three animals each according to their sex in clean iron cages. They were acclimatized for 14 days prior to sampling for blood parameters and weighed between 150 and 250 g using Ohaus weighing balance (Germany), and were fed cassava and yam tubers, fresh palm fruits and kernel and given clean drinking water ad libitum.

2.2. Study area

Nsukka is a suburban area and is located in the south-eastern Nigeria between latitudes 5°50′ north and longitude 6°52′ and 7°54′ east (FMARN 1999). It is an area of fairly high temperature which ranges from 21.17 to 32.00°C (FMARN 1999). The months for the rainy season are from March to October, while those of the dry seasons are from November to February. The relative humidity in Nsukka is about 70% during rainy season and 20% during dry season (FMARN 1999). These climatic factors are capable of affecting the haematological and serum biochemistry parameters of these Gambian rats in Nsukka metropolis.

2.3. Blood sample collection

Blood samples for the haematological and serum biochemical determinations were collected from the orbital sinus of the 18 African giant rats following the procedure of Stone (1954). These samples were collected between the hours of 8 and 11 in the morning on the same day. Blood samples (1 ml) for haematology were collected into sample bottles containing ethylene diamine tetra acetic acid (1 mg/ml of blood). For serum biochemical analysis, 3 ml of blood was put into plain glass tubes and sera harvested within 1 h after centrifuging the clotted blood with a clinical table centrifuge (A Jenner, India) at 3000 rpm for 15 min. The haematological and serum biochemical analyses were carried out immediately upon blood collection.

2.4. Haematological and serum biochemistry procedures

Haematological and serum biochemistry determinations were carried out following standard procedures. PCV was determined by the micro-haematocrit method (Thrall & Weiser 2002). Hbc was determined by the cyanomethaemoglobin method (Higgins et al. 2008). RBC count and total leucocyte count (TLC) were carried out by the haemocytometer method (Thrall & Weiser 2002), differential leucocyte count was done by making a blood smear on a clean glass slide and staining it following the Leishman technique. The different cells of the leucocytic series were enumerated by the battlement counting method (Thrall & Weiser 2002). The mean corpuscular values – mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) – was calculated using the standard formulae (Coles 1986). Serum biochemistry determinations were carried out using commercial test kits, Quimica Clinica Aplicada (QCA) test kits (QCA, Spain), Randox test kits (Randox, UK) for total proteins and albumin, and a digital colorimeter (Lab-tech, India). Serum ALT and AST activities were determined by the Reitman–Frankel method (Reitman & Frankel 1957). Serum ALP activity was determined by the phenolphthalein mono phosphate method (Babson et al. 1966), while total serum proteins were determined by the direct Biuret method (Lubran 1978). Serum albumin was determined by the Bromocresol green method (Doumas et al. 1971). Serum globulin was calculated as the difference between serum total proteins and serum albumin (Colvill 2002), while serum total bilirubin was determined by the Jendrassik–Grof method (Doumas et al. 1973). BUN was determined by the Berthelot–Seary method (Fawcett & Scott 1960), while serum creatinine was determined by the modified Jaffe method (Blass et al. 1974). Serum cholesterol was determined by the enzymatic colorimetric method (Allain et al. 1974).

2.5. Statistical analysis

Data generated from the study were subjected to descriptive statistics using SPSS version 16.0. Differences between the haematological and serum biochemistry parameters of the male and female juvenile Gambian pouched rat were analysed using Student’s t-test. The data were presented as means and
standard deviation, and the minimum and maximum values for each parameter. Significant difference was accepted at the probability level, \( p < .05 \).

### 3. Results

The overall mean values, with the minimum and maximum values for the erythrocytic parameters, were as follows: PCV – 34.87 ± 0.76% (31.00–39.00); RBC count – 9.33 ± 0.66 × 10^6/µl (6.26–13.40); Hbc – 10.27 ± 0.23 g/dl (9.26–12.63); MCV – 10.27 ± 3.19 fl (25.37–58.27); MCH – 11.91 ± 0.72 (7.78–16.82) and MCHC – 29.23 ± 1.04 g/dl (23.74–37.15) (Table 1). The overall mean values for the leukocytic parameters were as follows: TLC – 7.74 ± 0.14 × 10^9/µl (7.00–9.05); segmented neutrophil – 4.54 ± 0.08 × 10^9/µl (4.16–5.34), 58.53 ± 0.97% (52.00–67.00); band – 0.07 ± 0.02 × 10^9/µl (0.00–0.23), 0.87 ± 0.27% (0.00–2.30); lymphocyte – 2.69 ± 0.08 × 10^9/µl (2.31–3.20), 34.53 ± 0.81% (30.00–40.00); monocyte – 0.14 ± 0.02 × 10^9/µl (0.00–0.30), 1.87 ± 0.29% (0.00–4.00); eosinophil – 0.26 ± 0.03 × 10^9/µl (0.00–0.48), 3.67 ± 0.47% (0.00–6.00); basophil – 0.16 ± 0.23% (0.00–0.37) (Table 2).

#### Table 1. The erythrocytic profile of juvenile wild African giant rat (C. gambianus).

| Erythrocytic parameters | Mean ± SD (n = 18) | Minimum and maximum values |
|-------------------------|--------------------|---------------------------|
| Packed cell volume (%)  | 34.87 ± 2.92       | 31.00–39.00               |
| Red blood cell count (>10^6/µl) | 9.23 ± 2.57 | 5.26–13.40               |
| Haemoglobin concentration (g/dl) | 10.27 ± 0.86 | 9.26–12.63               |
| Mean corpuscular volume (fl) | 40.23 ± 12.86 | 25.37–58.27              |
| Mean corpuscular haemoglobin (pg) | 11.91 ± 2.79 | 7.78–16.82               |
| Mean corpuscular haemoglobin concentration (g/dl) | 29.23 ± 4.03 | 23.74–37.15             |

#### Table 2. The leukocytic profile of juvenile wild African giant rat (C. gambianus).

| Leukocytic parameters | Mean ± SD (n = 18) | Minimum and maximum values |
|----------------------|--------------------|---------------------------|
| Total leukocyte count (>10^9/µl) | 7.74 ± 0.53 | 7.00–9.05               |
| Band neutrophil (%) | 0.87 ± 0.16 | 0.00–3.00               |
| Segmented neutrophil (%) | 58.53 ± 3.76 | 52.00–67.00           |
| Lymphocyte (%) | 34.53 ± 3.14 | 30.00–40.00           |
| Monocyte (%) | 1.87 ± 1.13 | 0.00–4.00               |
| Eosinophil (%) | 3.67 ± 1.84 | 0.00–6.00               |
| Basophil (%) | 0.93 ± 0.88 | 0.00–2.00               |
| Band neutrophil (>10^9/µl) | 0.07 ± 0.08 | 0.00–0.23               |
| Segmented neutrophil (>10^9/µl) | 4.54 ± 0.32 | 4.16–5.34               |
| Lymphocyte (>10^9/µl) | 2.69 ± 0.33 | 2.31–3.20               |
| Monocyte (>10^9/µl) | 0.14 ± 0.09 | 0.00–0.30               |
| Eosinophil (>10^9/µl) | 0.26 ± 0.12 | 0.00–0.48               |
| Basophil (>10^9/µl) | 0.07 ± 0.07 | 0.00–0.16               |

#### Table 3. The serum biochemistry profile of juvenile wild African giant rat (C. gambianus).

| Serum biochemistry parameters | Mean ± SD (n = 18) | Minimum and maximum values |
|-----------------------------|--------------------|---------------------------|
| Alanine aminotransferase (U/l) | 18.09 ± 6.01 | 13.40–25.49          |
| Aspartate aminotransferase (U/l) | 7.65 ± 12.98 | 54.58–128.54         |
| Alkaline phosphatase (U/l) | 102.08 ± 9.08 | 83.18–111.82         |
| Total cholesterol (mg/dl) | 62.86 ± 22.86 | 20.00–140.00         |
| Total proteins (g/dl) | 4.70 ± 0.36 | 4.03–5.18             |
| Albumin (g/dl) | 2.08 ± 0.19 | 1.77–2.32             |
| Globulin (g/dl) | 2.64 ± 0.27 | 2.26–3.08             |
| Total bilirubin (mg/dl) | 3.71 ± 0.28 | 3.46–4.32             |
| BUN (mg/dl) | 2.73 ± 0.40 | 2.34–3.11             |
| Creatinine (mg/dl) | 0.82 ± 0.25 | 0.50–1.00             |

#### Table 4. Comparison of the erythrocytic profile of the male and female juvenile wild African giant rat (C. gambianus).

| Erythrocytic parameters | Mean ± SD, with minimum and maximum values in brackets |
|-------------------------|--------------------------------------------------|
| Packed cell volume (%)  | 35.29 ± 2.36 (33.00–39.00)                       |
| Red blood cell count (>10^6/µl) | 9.23 ± 2.57 (6.35–13.40) |
| Haemoglobin concentration (g/dl) | 10.04 ± 0.57 (9.26–10.53) |
| Mean corpuscular volume (fl) | 43.65 ± 14.83 (25.37–58.27) |
| Mean corpuscular haemoglobin (pg) | 12.68 ± 2.43 (9.43–15.24) |
| Mean corpuscular haemoglobin concentration (g/dl) | 28.85 ± 4.45 (23.74–33.97) |

#### Table 5. Comparison of the leukocytic profile of the male and female juvenile wild African giant rat (C. gambianus).

| Leukocytic parameters | Mean ± SD, with minimum and maximum values in brackets |
|----------------------|--------------------------------------------------|
| Total leukocyte count (>10^9/µl) | 7.53 ± 0.35 (7.15–8.10) |
| Band neutrophil (%) | 1.00 ± 0.14 (0.00–3.00) |
| Segmented neutrophil (%) | 59.71 ± 0.06 (57.00–62.00) |
| Lymphocyte (%) | 33.57 ± 2.94 (30.00–37.00) |
| Monocyte (%) | 1.57 ± 0.53 (1.00–2.00) |
| Eosinophil (%) | 3.86 ± 1.77 (1.00–6.00) |
| Basophil (%) | 1.11 ± 0.90 (0.00–2.00) |
| Band neutrophil (>10^9/µl) | 0.08 ± 0.11 (0.00–0.23) |
| Segmented neutrophil (>10^9/µl) | 4.49 ± 0.24 (4.22–4.86) |
| Lymphocyte (>10^9/µl) | 2.53 ± 0.23 (2.34–2.84) |
| Monocyte (>10^9/µl) | 0.10 ± 0.04 (0.07–0.16) |
| Eosinophil (>10^9/µl) | 0.25 ± 0.08 (0.08–0.30) |
| Basophil (>10^9/µl) | 0.09 ± 0.07 (0.00–0.16) |
than that of the females but not significant (p > .05) (Table 6). The AST and creatinine values were higher (not significant, p > .05) in the females than in the males (Table 6).

4. Discussion

Determination of the PCV, Hbc and RBC count of the juvenile African giant rat showed narrow range of values which are typical of many rodents such as the birch mouse (Wolk 1985), inbred juvenile cotton rat (Robel et al. 1996), adult African giant rat (Oyewale et al. 1998b), laboratory albino rat (Ihedioha et al. 2004), African soft-furred rat (Kagira et al. 2005), wild African grasscutter (Opara et al. 2006) and brush-tailed rat (Jekl et al. 2011). The mean RBC count recorded in this study is higher than that reported for wild juvenile cotton rat (Robel et al. 1996) and juvenile laboratory rat (Ihedioha et al. 2004), and not different from that reported for the mole rat (Broekmann et al. 2006). These differences could be attributed to nutrition, management and species differences. Also, the higher circulating number of RBCs of the African giant rat when compared to the laboratory rat could be due to their fossorial habit. They live in burrows, and occasionally come out at night for brisk foraging in the wild. The higher RBC count in the studied rat could also be due to the increased number of reticulocytes as reticulocyte counts of young rodents constitute up to 40–90% compared to that of adult and old rodents (2–5%) (Bolliger & Evers 2010). The increase in RBC numbers without a concurrent increase in PCV and Hbc in the studied African giant rat is not clearly understood, but may be attributed to the burrowing activity of the rat as it lives in burrows of low environmental oxygen level (hypoxia) and high carbon dioxide level (hypercapnia) due to limited exchange of oxygen and carbon dioxide through the soil (Roper et al. 2001). It has also been reported that reduction in Hbc occurs during the postnatal period in rodents (a phenomenon known as physiological anaemia) (Bolliger & Evers 2010) and in certain situations in which adjustments take place to compensate for the hypoxic condition seen in burrowing animals (Rogers 2011). Furthermore, this lack of haematological adaptation (increased number of RBC count without a commensurate increase in PCV and haemoglobin concentration) may be compensated by increased blood vessel density that endowed the African giant rat with physiological tolerance and adaptation to their hypoxic and hypercapnic conditions in the deep burrows (Avivi et al. 2005). The lack of significant sex-related variation in PCV is in agreement with that reported for wild juvenile cotton tail rabbit (Dawyne et al. 1991).

The mean TLC value in the studied giant rat is similar to that reported for the juvenile laboratory rat (Ihedioha et al. 2004). The lack of significant sex-related differences in the TLC, lymphocyte, neutrophil, monocyte and eosinophil numbers is not in agreement with that reported for the juvenile laboratory rat (Ihedioha et al. 2004). Stress of capture, acclimatization and several environmental factors may be the reason for the lack of remarkable sex-related differences in the differential leukocyte count. In the present study, neutrophils comprised a greater number and lymphocytes a small number of the leukocyte population. This agrees with previous report in inbred cotton rat (Robel et al. 1996). This is different from what was reported for the juvenile laboratory rat (Ihedioha et al. 2004), where lymphocytes were the numerous leukocytes.

The mean serum ALT and ALP values were lower, while the mean serum AST and total bilirubin values were slightly higher than that reported by Onwuka et al. (2003) for juvenile African giant rat. In this study, serum ALT activity was higher in females than in males, and this was in agreement with that reported by Onwuka et al. (2003). Serum total protein level was lower in the studied rat than that reported for juvenile laboratory rat, and may be attributed to diet; as laboratory rat are fed standard diet in the experimental animal house, while the wild rat has difficulty in accessing food (protein) (Madjdzadeh et al. 2011). The means and range of values for the serum albumin, globulin, creatinine and total cholesterol levels in the male and female juvenile African giant rat were lower than those reported by Nssien et al. (2002) and Onwuka et al. (2003). Nssien et al. (2002) reported no significant sex-related variation in the serum albumin level and this is not similar to that in the present study, as the serum albumin level of the females is significantly higher than that of the males. The mean BUN value recorded in the present study is comparable to but slightly higher than that reported by Onwuka et al. (2003). The lack of sex-related variations in the BUN concentration of the juvenile African giant rat in the present study was different from that reported by Onwuka et al. (2003). The significant differences in the serum ALT activity and serum albumin

| Table 6. Comparison of the serum biochemistry profile of the male and female juvenile African giant rat (C. gambianus). |
|-----------------------------------------------|-----------------------------------------------|
| Serum biochemistry parameters Mean ± SD, with minimum and maximum values in brackets |
|-----------------------------------------------|-----------------------------------------------|
| Males (n = 8) | Females (n = 10) |
|-----------------------------------------------|-----------------------------------------------|
| Alanine aminotransferase (U/l)* | 13.33 ± 1.24 (11.91–15.64) | 23.04 ± 4.42 (21.11–25.49) |
| Aspartate aminotransferase (U/l) | 66.91 ± 13.21 (54.58–91.56) | 85.40 ± 31.23 (54.58–128.54) |
| Alkaline phosphatase (U/l) | 101.30 ± 12.69 (83.18–111.82) | 122.40 ± 20.68 (98.18–107.73) |
| Total cholesterol (mg/dl) | 91.43 ± 39.76 (40.00–140.00) | 94.20 ± 22.25 (20.00–40.00) |
| Total proteins (g/dl) | 4.60 ± 0.51 (4.03–5.18) | 4.80 ± 0.00 (4.80–4.80) |
| Albumin (g/dl)* | 1.93 ± 0.10 (1.77–2.05) | 2.22 ± 0.18 (1.91–2.32) |
| Globulin (g/dl) | 2.66 ± 0.36 (2.26–3.08) | 2.62 ± 0.18 (2.48–2.89) |
| Total bilirubin (mg/dl) | 3.83 ± 0.30 (3.46–4.32) | 3.58 ± 0.21 (3.46–3.89) |
| BUN* (mg/dl) | 2.45 ± 0.29 (2.34–3.11) | 3.00 ± 0.29 (2.34–3.11) |
| Creatinine (mg/dl) | 0.76 ± 0.27 (0.50–1.00) | 0.86 ± 0.24 (0.50–1.00) |

Note: Asterisk superscript on any parameter indicates significant difference between males and females (p < .05).
concentration in the female and male juvenile African giant rat were not clearly understood and neither is its significance, but may be attributed to the differences in their metabolic activities (Onwuka et al. 2003). The significantly higher serum BUN level in females than males without a significant concurrent increase in serum creatinine level suggests a high protein metabolism in females than males (Jekl et al. 2011). The differences in the values of the serum biochemistry parameters in the present study and those reported by Nssien et al. (2002) and Onwuka et al. (2003) (south-western Nigeria) may be attributed to climatic factors such as temperature and humidity.

In conclusion, the biochemical data obtained showed that the mean ALT, ALP, total proteins, albumin, creatinine and total cholesterol values were lower than that reported in the available literature for juvenile African giant rat. Sex-related differences were recorded for the serum ALT, albumin and BUN values, which were higher in females than males. Therefore, the present study has presented preliminary information on the range of haematological and serum biochemistry parameters, which may be useful to biomedical researchers and veterinary clinicians. These findings may enhance the future role of the African giant rat as a laboratory rodent and pet animal under veterinary care.

**Disclosure statement**

No potential conflict of interest was reported by the authors.

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