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# Ichthyohaematological Studies on the Electric Catfish, *Malapterurus eletricus* (Gmelin, 1789).

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## ABSTRACT

Haematological profile of *Malapterurus eletricus* (Gmelin 1789) was determined. The physical parameters of erythrocyte and leucocytes, haemoglobin concentration, haematoctit value and erythrocyte sedimentation rate, were 0.852960 ± 1.2914989($10^6mm^{-3}$), 0.22872 ±0.497 ($10^4mm^{-3}$), 14.36 ± 2.34g/dl, 31 ± 2.84% respectively. The erythrocyte indices of mean corpuscular volume mean corpuscular haemoglobin concentration and mean corpuscular haemoglobin were 0.052 ±0.02FL, 46.03 ± 3.44g/dl, 0.000024 ± 0.0000079pg, respectively. Plasma electrolytes were: plasma sodium 25.90 ± 4.02mM, plasma potassium 14.13 ± 3.83mM, plasma chloride 3.8 ± 2.37mM, plasma magnesium 9.09 ± 4.39mM, plasma glucose 43.12.± 16.07mg/dl.and plasma albumin7.53 ± 1.83mg/dl. Where there was a positive correlation between some parameters (e.g. erythrocyte and leucocytes r 0.740 at p≤0.01 level), there was a negative correlation between others (e.g. erythrocyte and mean cell haemoglobin r-0.834 at p≤0.01 level). Implications of the results are discussed.


**KEY WORDS**: Icthyohaematological, Electric catfish, *Malapterurus eletricus*, blood parameters (blood counts, eletrocytes, and biochemicals)

## INTRODUCTION

Ichthyohaematological values have been widely used as indices to asses the state of fish health, provide a basis for chemical diagnosis of disease and pathologies of fish (Kori-siakpere, 1985; Erondu *et al,* 1993). Haematological characteristics also provide a mean of monitoring the physiological response to envinronmental stress (Soivio and Oikari, 1976) as well as give useful information concerning the sufficiency of a given diet (Fagbenro *et al* 1993).

The need to provide information on normal haematological profile for fish species has led to the development of standard procedures for the sampling procedures for the sampling and analysis of fish blood (Blaxhall and Daisley, 1973; Miller *et al*; 1983; Svobodova *et al* 1991).

The icthyohaematological profile of a few tropical African fish species have been reported, mainly for tilapia (Ezzat *et al* 1974; Boon *et al,* 1987) four catfishes - *Clarias gariepinus*, *Heterobranchus longifilis*, F1 hybrids(C.g xH.l) and *Chrysichths nigrodigitatus* (Erondus *et al* 1993); *Heterobranchus bidorsalis* (Fagbenro *et al* 1993) and African bony- tongue, *Heterotis niloticus* (Fagbenro *et al* 2001). Of all the haematological parameters, haematocrit, erythrocyte counts and haemoglobin concentration are the most readily determined under field and hatchery conditions (Bhaskar and Rao, 1990).

The African electric catfish, *Malapterurus eletricus* posses an electric organ, a quality peculiar to it, of all the catfishes. Some studies have been done on the African electric cat fish, *M. electricus* including those of Olatunde, (1983) on the length-weight relationship of *Malapterurus eletricus*; Emere (1999) on sex ratio, fecundity and reproductive cycle of *Malapterurus eletricus*; Fagbenro *et al* (2001) on food composition and digestive enzymes in the gut of an African electric catfish, *Malapterurus eletricus*. But none has been carried out on the haematological profile to date. This study was undertaken to establish a normal haematological profile for *Malapterurus electricus*, which is lacking, and provide a basis for comparative surveys.

## MATERIALS AND METHODS

Twenty-five live *Malapterurus electricus* species were obtained from artisanal fishermen in the Upper Cross River. They were kept in a large transparent glass tank (121.5 litres capacity) supplied with filtered and aerated unchlorinated well water for a period of one week to acclimate to laboratory condition. No sexual selection was made. During the period of acclimation, the fish were fed twice daily with a pelleted diet of 35%

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Table 1: SUMMARY OF ICHTHYOHAEMATOLOGICAL PARAMETERS OF *Malapterurus electricus* n=25

| S/N | PARAMETERS | MEAN±S.D | RANGES |
|---|---|---|---|
| 1 | Standard length (cm) | 13.80 ±1.02 | 12.2 – 16.0 |
| 2 | Weight (g) | 175.4 ± 30.36 | 140 – 244 |
| 3 | Haemoglobin (g/dl) | 14.36 ± 2.34 | 10 – 18 |
| 4 | Haematocrit (%) | 31 ± 2.84 | 25 – 35 |
| 5 | Erythrocyte sedimentation rate (%) | 58.32 ± 7.67 | 45 – 70 |
| 6 | Red blood cell ($10^6$/mm$^3$) | 0.852960±1.291498 | 0.28 – 0.868 |
| 7 | White blood cell ($10^4$/mm$^3$) | 0.22872 ± 0.497 | 1.62 – 2.94 |
| 8 | Mean corpuscular haemoglobin concentration (g/dl) | 46.03 ± 3.44 | 40 – 51.4 |
| 9 | Mean corpuscular volume (FL) | 0.052 ± 0.02 | 69 x $10^{-3}$- 1.2x$10^{-1}$ |
| 10 | Mean corpuscular haemoglobin (pg) | 0.000024 ± 0.0000079 | 2.3x$10^{-5}$- 2.7x$10^{-5}$ |
| 11 | Plasma Sodium (mM) | 26.8 ± 4.16 | 19.5 – 33.4 |
| 12 | Plasma Potassium (mM) | 14.13 ± 3.85 | 8.5 – 22.5 |
| 13 | Plasma Chloride (mM) | 3.87 ± 2.37 | 0.5 – 95 |
| 14 | Plasma Magnesium (mM) | 9.09 ± 4.39 | 3.5 – 16.7 |
| 15 | Plasma Phosphorus (mM) | 271.53 ± 87.68 | 125.2 – 420.5 |
| 16 | Plasma Protein (g/l) | 7.93 ± 14.15 | 0.7 – 9.2 |
| 17 | Plasma glucose (mg/dl) | 43.12± 16.07 | 25.0 – 73.0 |
| 18 | Plasma albumin (mg/dl) | 7.53 ± 1.83 | 4.3 – 10.2 |

crude protein, 65% energy, 4% fat and oil, 4% Vitamin premix and 2% Salt. All the fish were considered health on the basis of their appearance and absence of obvious sgns of diseases.

### Water Quality Analysis.

Dissolved oxygen concentration was determined using a digital, dissolved oxygen meter (Jenway 9071), pH was determined using a digital pH meter (Mettler Toledo 320). Temperature was determined using mercury in glass thermometer. The mean water characteristics were: temperature 26.59°C, pH 6.82 and dissolved oxygen 5.6mg/l.

### Blood Collection.

Blood (5-10ml/fish) was collected from vertebral blood vessels towards the caudal peduncle of each fish using separate heparinized syringes and treated with ethylene-diamine tetraacetic acid (EDTA) which served as an anti-coagulant (Svobodova et al, 1991). Plasma was obtained from non clotted samples by centrifugation for 5 minutes at 10,500 rpm, and stored at -4oC. This was later used for determination of total plasma protein, plasma glucose and plasma electrolyte. Prior to the blood sampling individual standard lengths (cm) and weights (g) of fish were measured.

### Blood Analysis

The method of blood analysis described by Svobodova *et al* (1991) was followed. Blood cell count (Erythrocytes and Leucocytes) were enumerated in an improved Neubaeur haemocytometer using a modified Yokoyama diluting fluid.

The basic erythrocyte indices, Mean Cell Haemoglobin Concentration (MCHC), Mean Corpuscular Volume (MCV), and Mean Corpuscular Haemoglobin (MCH) were computed from haemoglobin values and erythrocyte counts. The biochemical analysis (total protein level, plasma glucose, and plasma albumin) was determined by the method described by Svobodova *et al* (1991). The plasma electrolytes (Plasma sodium and potassium) were determined by flame photometry using a corning 400 Photometer. Plasma magnesium was determined using MODEL 200A Flame Atomic Spectrophotometer. Plasma Chloride was done by titrimetric method described by Schales (1941); while Plasma phosphrous was determined by spectrophotometer method (Fiskia and Subarrow, 1956).

**Analysis of Data**

All the data were collated and analyzed using computerized, Probit and Logit Analysis

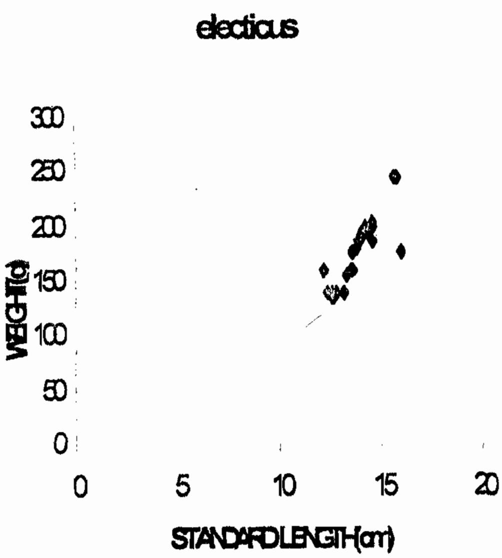


FIGURE1:GRAPH SHOWING LENGTH WEIGHT RELATIONSHIP OF M

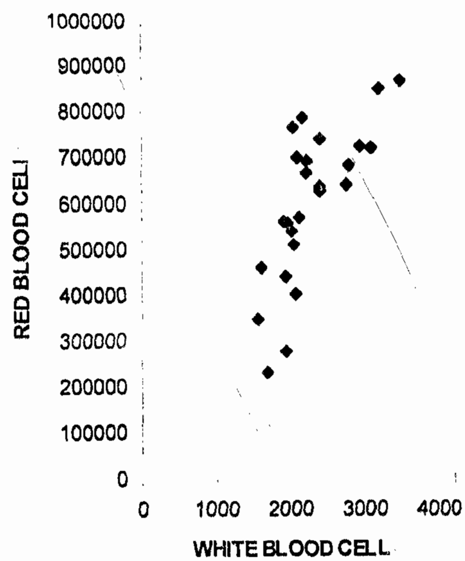


FIGURE3: GRAPH SHOWING THE CORRELATON BETWEEN RBC AND WBC

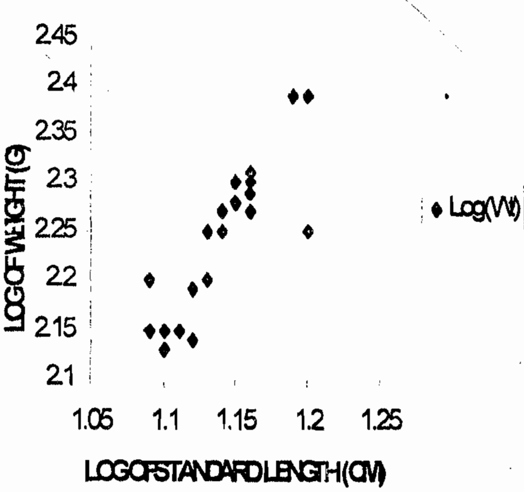


FIGURE2: GRAPH SHOWING LOG OF STANDARD LENGTH LOG OF WEIGHT OF M electicus

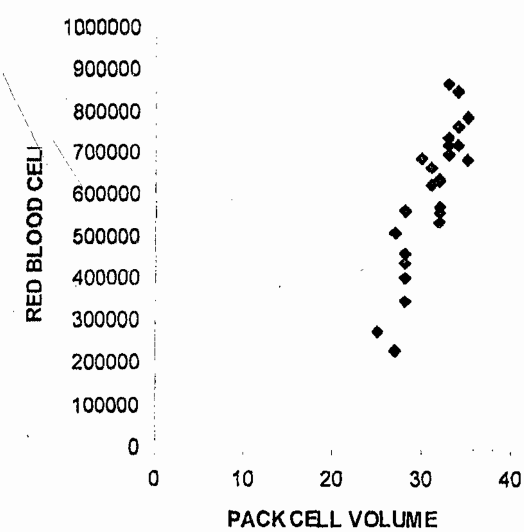


FIGURE4: GRAPH SHOWING THE CORRELATIONS BETWEEN RBC AND PCV

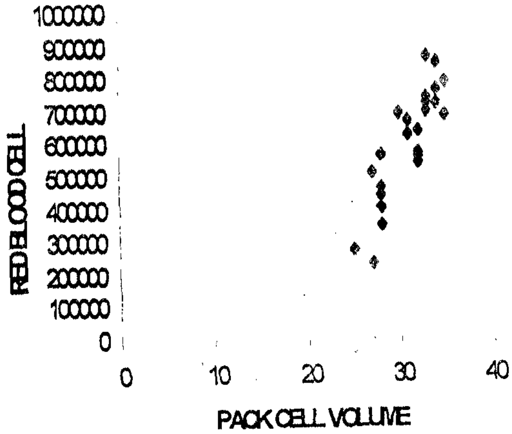


FIGURE5: GRAPH SHOWING THE CORRELATION BETWEEN RBC AND PCV

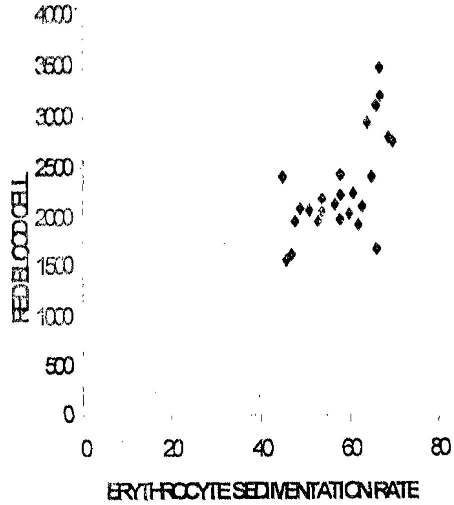


FIGURE7: SHOWING THE CORRELATION BETWEEN WBC AND ESR

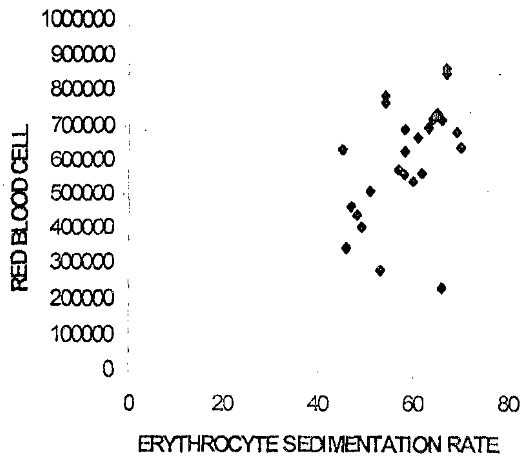


FIGURE6: GRAPH SHOWING THE CORRELATION BETWEEN RBC AND ESR

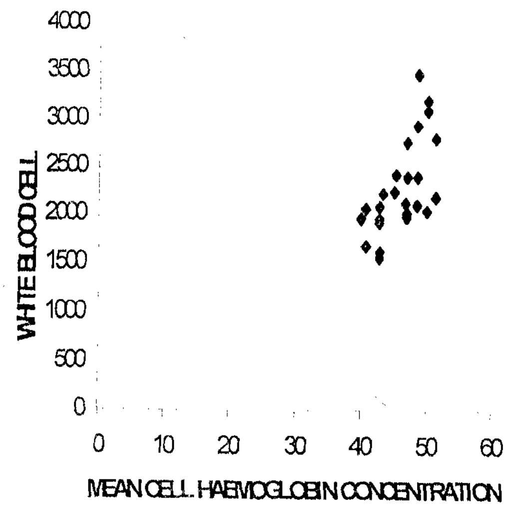


FIGURE8: SHOWING THE CORRELATION BETWEEN WBC AND MCHC

(Lichfield and Wilcoxin, 1949). Regression analysis and correlation coefficient (F) were used to determine the relationship of various confidence levels among the values obtained from parameters in blood analysis.

## RESULTS

The mean values for the blood parameters are presented in Table 1, based on a sample of 25 fish sample used in the study. There were intraspecies variations in blood values as indicated by the wide ranges of some parameters in this study. The levels of correlation among the different blood parameters are presented in figures 1-14.

## DISCUSSION

The result presented in Table 1 show intraspecies variation in haematological values of *Malapterurus eletricus*, and is similar to those reported for other fresh water teleost species. The variability in the level of haematological parameters obtained in this study is similar to those reported by Kori-Siakpere (1985), Erondu *et al* (1993), Fagbenro *et al* (1993) and Fagbenro *et al* (2000). The factors responsible for haematological variations within a given species have been attributed age, size of fish, season of

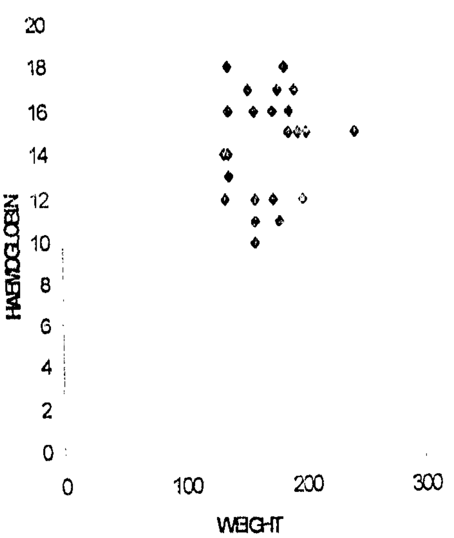


FIGURE9: GRAPH SHOWING THE CORRELATION BETWEEN WEIGHT AND HAEMOGLOBIN

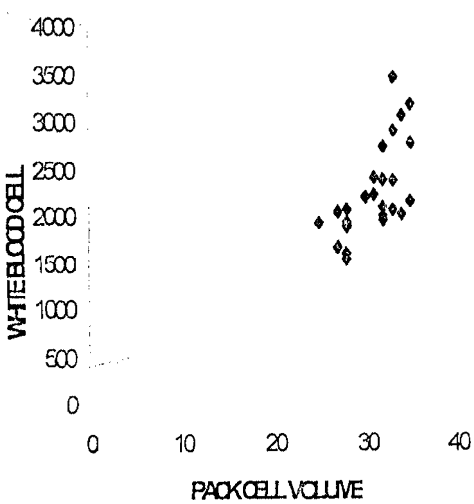


FIGURE10: GRAPH SHOWING THE CORRELATION BETWEEN WBC AND PCV

year and nutrition state (McCarthy *et al* 1973). Other factors reported to be responsible for intraspecies variation are, spawning, migration, sex, genetic variation, and stress due to capture, handling and sampling procedure (Das, 1965).

The value of erythrocyte count obtained for this study (Table 1) ranged from 0.28 x $10^6$mm$^{-3}$ – 0.868 x $10^6$mm$^{-3}$ with a mean value of 0.60096 x $10^6$mm$^{-3}$, which was similar to those reported by Erondu *et al* (1993), for four cat fishes, *Clarias gariepinus*, *Heterobranchus longifilis*, F1 hybrids C.g x H.L) and

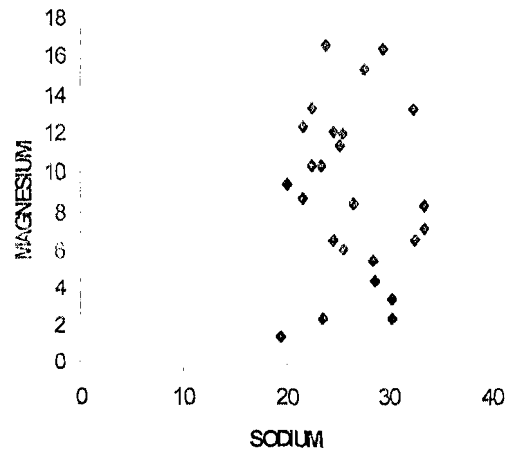


FIGURE11: GRAPH SHOWING THE CORRELATION BETWEEN SODIUM AND MAGNESIUM

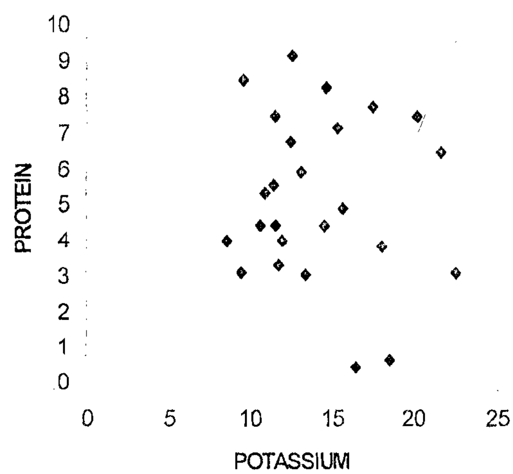


FIGURE12:GRAPH SHOWING THE CORRELATION BETWEEN POTASSIUM AND PROTEIN

*Chrysichththys nigrodigitatus*, were 0.66 – 1.96 x $10^6$mm$^{-3}$, 1.59 – 1.72 x $10^6$mm$^{-3}$, 1.07 – 1.93 x $10^6$mm$^{-3}$ and 1.05 – 1.65 x $10^6$mm$^{-3}$ respectively. The high value of erythrocyte counts and haemoglobin (14.36 ±2.34g/dl) concentration reflect a high oxygen carrying capacity of the blood which consistent with the correlation of haemoglobin concentration and fish activities. The erythrocyte counts obtained in this study fall within the normal range of 0.5 – 2.6 x $10^6$mm$^{-3}$ cited in Blaxhall (1972).

The haemoglobin value obtained in this study were higher (mean 14.36 ± 2.34g/dl) than the ones obtained by Erondu *et al* (1993), for *C. gariepinus* (11.64 ± 2.93g/dl), *H.longifilis* (11.27 ± 2.55g/dl), F1hybrid (C.g x H. l., 8.96 ± 1.96g/dl)

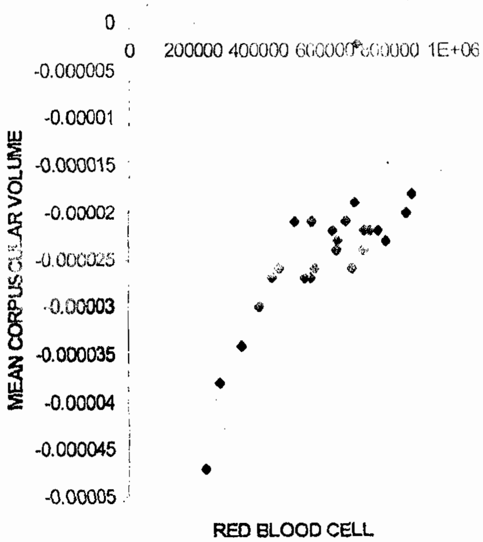


FIGURE13: GRAPH SHOWING NEGATIVE CORRELATION BETWEEN RBC AND MCH

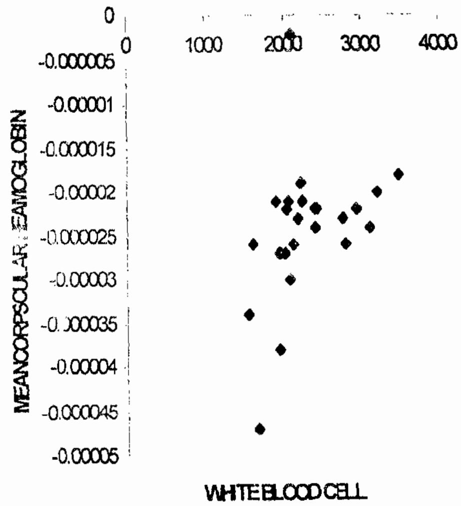


FIGURE15: GRAPH SHOWING THE NEGATIVE CORRELATION BETWEEN WBC AND MCH.

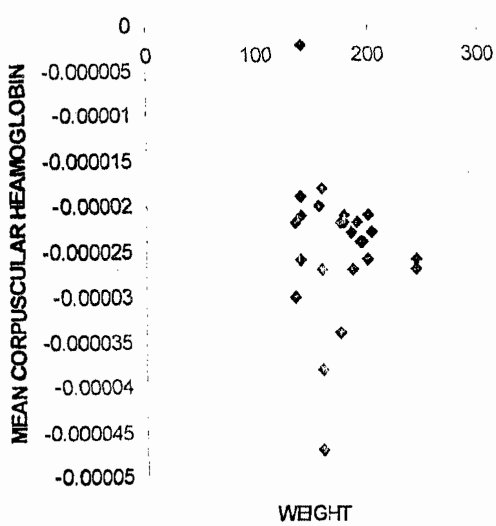


FIGURE14: GRAPH SHOWING NEGATIVE CORRELATION BETWEEN WEIGHT AND MCH.

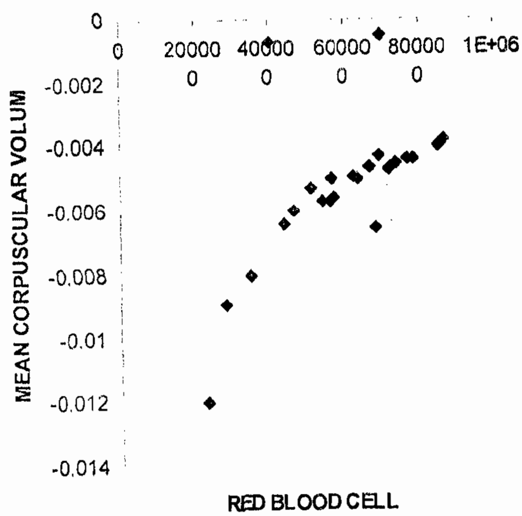


FIGURE16: GRAPH SHOWING NEGATIVE CORRELATION BETWEEN RBC AND MCV

and *C. nigrodigitatus* (8.66 ± 1.91g/dl). Fagbenro *et al* (1993) reported haemoglobin mean value of 5.43 ± 0.25g/mm3 for the feral catfish, *Heterobranchus bidorsalis*, but positively correlated with mean haemoglobin value of 14.56g/dl for *Clarias isheriensis* (Kori-Siakpere1985).

The high erythrocyte count and haemoglobin (Table 1) reflect a high oxygen carrying capacity of the blood, which is consistent with a high haemoglobin concentration and fish activity. Lenfant and Johansen (1972) opined that haemoglobin concentration is higher in fish capable of aerial respiration. *Malapterurus eletricus* can tolerate very low values of dissolved oxygen because it is able to undertake aerial respiration via the air bladder (D'Aubenton 1955). Thus the high haemoglobin value in *Malapterurus eletricus* is indicative of its air breathing character and high activity.

The low value of white blood cell (0.165 – 2.94 x $10^6 mm^{-3}$) recorded in this study is negatively correlated with the work of Fagbenro e*t al* (1993), who reported a higher value of 0.8 – 7.36 x $10^4 mm^{-3}$ for feral catfish, *H. bidorsalis*. While Erondu *et al* (1993) reported leucocyte teleost fish reflecting a modification in the distribution of water and salt in both plasma and tissue.

There is no correlation found between blood parameters of erythrocytes, leucocytes and haemoglobin and the physical parameters of length and weight, biochemical analysis of plasma protein, plasma glucose and plasma albumin. Similarly, no correlation was found between the physical parameters of length and weight and plasma electrolyte – plasma sodium, plasma potassium, plasma chloride, plasma magnesium and plasma phosphorus.

Mean plasma protein values of 7.93 ± 1.415g/l was obtained for *M.electricus*. This is relatively low when compared with the value reported for *H. niloticus* (57.10 ± 4.7 g/l) by Ayotunde (1998). Ayotunde (1998) also reported higher values for plasma glucose (61.46±5.29mg/l) compared with 43.12±16.07mg/l obtained in this study. However, a higher value (7.53±1.83mg/l) of plasma albumin was obtained for *M. electricus* in this study than Ayotunde (1998) reported for H. niloticus (4.76±0.83mg/l mg/l).

Bhaskar and Rao (1990) stated that plasma constituents (particularly sodium and potassium ion concentrations) rather than erythrocytes and leucocytes parameters are better indicators of the condition of fish in aquaculture.

This study provides standard haematological values for *M. electricus*. It enables changes in blood profile resulting from disease or toxic environmental effects to be detected. The results also provide a basis against which future studies can be compared.

## ACKNOWLEDGEMENT

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**Table 2: THE LINEAR REGRESSION ANALYSIS OF THE BLOOD PARAMETERS WITH STANDARD LENGTHS (cm) AND WEIGHTS (g) OF *Malapterurus electricus*.**

| Model | Unstandardized Coefficient | | Standardized Coefficient | t | Sig. | Depended variables |
|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | | | |
| (constant) | -46.192 | 48.041 | - | -0.962 | 0.351* | Sl(cm) |
| RBC | -9.376E-06 | 0.000 | -1.540 | -1.228 | 0.237* | |
| WBC | -2.108E-04 | 0.001 | -0.102 | -0.273 | 0.788* | |
| PCV | 1.569 | 1.284 | 4.348 | 1.222 | 0.239* | |
| ESR | -1.229E-04 | 0.042 | -0.001 | -0.003 | 0.998* | |
| Hb | -3.767 | 3.253 | -8.606 | -1.158 | 0.264* | |
| MCH | -95297.769 | 120371.78 | -0.594 | -0.792 | 0.440* | |
| MCV | -6.609 | 22.810 | -0.101 | -.290 | 0.776* | |
| MCHC | 1.615 | 1.295 | 5.420 | 1.248 | 0.230* | |
| CONSTANT | -698.885 | 1546.244 | - | -0.452 | 0.657* | Wt (g) |
| RBC | -3.148E-04 | 0.000 | -1.747 | -1.282 | 0.218* | |
| WBC | -3.324E-03 | 0.025 | -0.054 | -0.134 | 0.895* | |
| PCV | 17.467 | 41.322 | 1.636 | 0.423 | 0.678* | |
| ESR | -0.233 | 1.344 | -0.059 | -0.173 | 0.865* | |
| Hb | -52.914 | 104.689 | -4.084 | -0.505 | 0.620* | |
| MCH | -4229487 | 3874252.6 | -0.890 | -1.092 | 0.291* | |
| MCV | -612.065 | 734.160 | -0.316 | -0.834 | 0.417* | |
| MCHC | 31.333 | 41.667 | 3.551 | 0.752 | 0.463* | |
| (Constant) | 11.157 | 1.801 | - | 6.195 | 0.000** | SL(cm) |
| $Na^+$ | 7.225E-02 | 0.049 | 0.283 | 1.467 | 0.158** | |
| $K^+$ | -1.899E-02 | 0.054 | -0.071 | -0.355 | 0.727** | |
| $Cl^-$ | -132 | 0.085 | -0.305 | -1.555 | 0.136** | |
| $Mg^+$ | 2.495E-02 | 0.044 | 0.107 | 0.561 | 0.581** | |
| $P^+$ | 4.915E-03 | 0.002 | 0.422 | 2.083 | 0.051** | |
| (constant) | 130.015 | 55.451 | - | 2.345 | 0.030** | Wt (g) |
| $Na^+$ | 0.406 | 1.514 | 0.54 | 0.268 | 0.792** | |
| $K^+$ | 0.811 | 1.648 | 0.102 | 0.492 | 0.628** | |
| $Cl^-$ | -5.363 | 2.609 | -0.419 | -2.056 | 0.054** | |
| $Mg^+$ | 1.106 | 1.369 | 0.160 | 0.808 | 0.429** | |
| $P^+$ | 0.126 | 0.126 | 0.364 | 1.729 | 0.100** | |

$*P \leq 0.05$. $**P \leq 0.01$.

counts of 1.0 – 4.3 x $10^6 mm^{-3}$, 2.35 – 3.75 x $10^4 mm^{-3}$, 1.25 – 4.5 x $10^4 mm^{-3}$ and 2.9 – 3.65 x $10^4 mm^{-3}$ for C. gariepinus, *H. longifilis*, F1hybrids (C.g x H.l) and *C. nigrodigitatus* respectively, which is similar the result of the present study.

The mean corpuscular haemoglobin concentration (MCHC), mean corpuscular haemoglobin (MCH), mean corpuscular volume (MCV) all reflect the trend of the erythrocyte and leucocytes counts already discussed.

A positive correlation exists between the leucocytes and erythrocyte counts (r 0.740 at $p \leq 0.01$). There was also a positive correlation between RBC and PCV (r0.862 at $P \leq 0.01$ level), Hb and RBC (r 0.847 at $P \leq 0.01$ level), Hb and PVC (r 0.994 at $P \leq 0.01$ level). These results are consistent with what should be expected of a species exhibiting high activity.

A negative correlation was found to exist between RBC and MCH (r -0.843 at $P \leq 0.01$), WBC and MCH (r -0.537 at $P \leq 0.01$), and MCV and ESR (r – 0.530 at $P \leq 0.01$). Similar results were obtained by Kori – Siakpere (1985) for *Clarias isheriensis.*

Higher values of plasma chloride (0.5 – 9.5mM) were obtained in this study than Ayotunde (1988) reported for *Heterotis niloticus* (0.07 – 1.63 mM). The higher values in this species may be due to its possession of electrical activities. Jacob (1982) reported seasonal changes in plasma osmotic concentration in

**Table 3: THE PEARSON CORRELATIONS BETWEEN DIFFERENTS BLOOD PARAMETERS OF *Malapterurus electricus*.**

| | SL(cm) | Wt(g) | RBC($10^6$mm$^3$) | WBC($10^4$mm$^3$) | PCV (%) | ESR (%) |
|---|---|---|---|---|---|---|
| SL(cm) | 1.000 | 0.847** | -0.102 | -0.181 | 0.099 | 0.124 |
| Wt(g) | 0.847** | 1.000 | -0.024 | -0.125 | 0.109 | -0.096 |
| RBC($10^6$mm$^3$) | -0.102 | -0.024 | 1.000 | 0.740** | 0.862** | 0.467* |
| WBC($10^4$mm$^3$) | -0.181 | -0.125 | 0.740** | 1.000 | 0.641** | 0.629** |
| PCV (%) | 0.099 | 0.109 | 0.862** | 0.641** | 1.000 | 0.498* |
| ESR (%) | -0.124 | -0.096 | 0.467* | 0.629** | 0.498* | 1.000 |
| Hb(g/dl) | 0.092 | 0.104 | 0.847** | 0.001 | 0.994** | 0.489* |
| MCH(pg) | 0.062 | -0.018 | -0.843** | -0.537** | 0.555** | 0.185 |
| MCV(FL) | 0.162 | 0.040 | -0.419* | -0.301 | -0.360 | -0.530** |
| MCHC(g/dl) | 0.107 | 0.115 | 0.833** | 0.636** | 0.985** | 0.469* |
| | SL(cm) | Wt(g) | Na+(mM) | K+(mM) | CL-(mM) | |
| SL(cm) | 1.000 | 0.847** | 0.259 | -0.224 | -0.193 | |
| Wt(g) | 0.847** | 1.000 | -0.003 | -0.003 | -0.339 | |
| $Na^+$(mM) | 0.259 | -0.003 | 1.000 | -0.140 | 0.098 | |
| $K^+$(mM) | -0.224 | -0.003 | -0.140 | 1.000 | 0.032 | |
| $CL^-$(mM) | -0.193 | -0.339 | 0.098 | 0.032 | 1.000 | |
| $Mg^+$(mM) | 0.147 | 0.206 | 0.037 | 0.075 | -0.038 | |
| $P^+$(mM) | 0.377 | 0.256 | -0.019 | -0.246 | 0.213 | |
| | Hb(g/dl) | MCH(pg) | MCV(FL) | MCHC(g/dl) | | |
| SL(cm) | 0.092 | 0.065 | 0.160 | 0.107 | | |
| Wt(g) | 0.104 | -0.018 | 0.040 | 0.115 | | |
| RBC($10^6$mm$^3$) | 0.847** | -0.843** | -0.419* | 0.833** | | |
| WBC($10^4$mm$^3$) | 0.642** | -0.537** | -0.360 | 0.636** | | |
| PCV(%) | 0.994** | -0.555** | -0.301 | 0.985** | | |
| ESR(%) | 0.489* | -0.185 | -0.530** | 0.469* | | |
| Hb(g/dl) | 1.000 | -0.523** | -0.319 | 0.997** | | |
| MCH(pg) | -0.523** | 1.000 | 0.184 | -0.510** | | |
| MCV(FL) | -0.319 | 0.184 | 1.000 | -0.274 | | |
| MCHC(g/dl) | 0.997** | -0.510** | -0.274 | 1.000 | | |
| | Mg+(mM) | P+(mM) | | | | |
| SL(cm) | 0.147 | 0.377 | | | | |
| Wt(g) | 0.206 | 0.256 | | | | |
| $Na^+$(mM) | 0.037 | -0.019 | | | | |
| $K^+$(mM) | 0.075 | -0.246 | | | | |
| $CL^-$(Mm) | -0.038 | 0.213 | | | | |
| $Mg^+$(Mm) | 1.000 | 0.055 | | | | |
| $P^+$(mM) | 0.055 | 1.000 | | | | |

n=25

** Correlation is significant at the P≤ 0.01 level (2 – tailed)

* Correlation is significant at the P≤ 0.05 level (2 – tailed)