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# HAEMATOLOGICAL PROFILE OF *CLARIAS GARIEPINUS* EXPOSED TO SUB-LETHAL CONCENTRATIONS OF DELTAMETHRIN

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## ABSTRACT

This study has investigated the changes of haematological profile of *Clarias gariepinus* exposed to sub-lethal concentration of deltamethrin over a 28 days exposure period. Sub-adults *C. gariepinus* (weight 134.21± 43.01g and length 17.34± 5.92cm) were exposed to control (0.00) 0.005, 0.011, 0.022 and 0.044 ppm concentrations of deltamethrin for 28-days. Significant changes were induced by the deltamethrin on the haematological parameters of *C. gariepinus* fish after 28 days exposure. We observed a concentration and exposure duration (time) dependent alterations in fish exposed to deltamethrin compared with control. Also, the red blood cells, haemoglobin and haematrocrit count, mean corpuscular volume, mean cell haemoglobin concentration, lymphocytes, platelets and white blood cells decreased significantly in deltamethrin exposure concentrations compared with control. Blood parameters showed a time-dependent decreased across exposure groups and concentrations. Results presented herein indicates a concentration and time-dependent alterations in hematological profile of *C. gariepinus* suggesting a negative physiological effects of deltamethrin on the hematological status of fish.

**KEYWORDS**: Heamatological, concentrations, Deltamethrin and *Clarias gariepinus*

## INTRODUCTION

Pesticides are the major potential environmental hazards to humans and animals as these are present and concentrated in the food chain. Pesticides can reach the environment via run-off from farmlands, industrial pollution and careless disposal of pesticide containers (Inyang *et al*., 2015). Alterations in water quality as a result of pesticides effects usually predispose fish to stress and diseases and may result in some physiological effects such as changes in haematological and biochemical parameters (Inyang *et al*., 2015).

Pesticides in general are primarily designed to control and eliminate pest. The wide use of chemicals to control pest has been recognized globally, with some reports highlighting the benefits of these chemicals mostly in vector control (Adelowa, 2004).

Blood as an essential fluid comprises of water, electrolytes, nutrients, proteins and other materials and serves as a vehicle that transports nutrients and oxygen to different parts of the body and eliminates waste products of metabolism, while also acting as part of the body's defense mechanisms (Ochei and Kolharker, 2003).

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Deltamethrin is a pesticide that is extensively used in agriculture, for controlling pests, vectors of endemic diseases and household insects control due to its low environmental persistence (Braguini *et al*., 2004). The extensive use of deltamethrin has resulted in it ubiquitous distribution in the ecosystems with possible adverse effects on other non-target organisms including wildlife (Braguini *et al*., 2004). It has been reported that the occurrence of deltamethrin in aquatic environment may produce adverse health effects on fish energy metabolism including ionic regulations (Khalili *et al*., 2012). It has been reported that deltamethrin has a high rate of gill adsorption due to the lipophilicity (Elells *et al*., 1995).

Fish are excellent model organism for ecotoxicological testing due to it close association with their aquatic environment and any changes in this environment would be reflected in alterations in their haematological studies (Golemi *et al*., 2012). Aquatic organisms, particularly fish, are highly sensitive to pesticides pollution (Assis *et al*., 2009). Due to their lipophilicity, pyrethroids have a high rate of gill absorption, which would be a contributing factor in the sensitivity of the fish to aqueous pyrethroid exposures. It has been found that the fish exhibit several symptoms of stress when treated with deltamethrin (Datta *et al*., 2003). Haematological analysis can provide valuable knowledge for monitoring the health and condition of the both wild and cultured fish. Other reports have demonstrated that haematological changes resulting from contaminants exposure is dependent on species, age, the cycle of sexual maturity and health condition (Vaiyanan *et al*., 2015). Due to the wide-spread application and use of deltamatrhin in several agricultural and public health process, this study is aimed at investigating the changes in the haematological parameters of *Clarias gariepinus* exposed to different concentrations of deltamethrin.

## MATERIALS AND METHODS

### *Test chemical*

The toxicant (deltamethrin) used for this study was purchased from Federal Ministry of Agriculture, Barrack Road, Calabar, Cross River State, Nigeria

### *Collection and Transportation of Test Fish*

Sub-adults of *Clarias gariepinus* were collected from fishery hatchery complex of University of Calabar fish farm, Calabar, with the aid of a scoop net in the early hours of the morning to avoid heat, high intensity and stress. Sub-adult of *Clarias gariepinus* were then transported using a plastic bucket to the postgraduate laboratory of Zoology and Environmental Biology, University of Calabar, where they were kept and allowed to acclimate for fourteen (14) days, prior to commencement of the experiment.

### *Acclimation and maintenance of study organisms*

In the laboratory, the fish samples were left to acclimate to laboratory conditions at room temperature for a period of two (2) weeks during which they were be fed with commercial fish feed (coppen) twice daily (8am in the morning and 4pm in the evening), at 4% of their body weight.

### *Preparation of stock solution*

A stock solution of deltamethrin, was prepared from the commercial grade deltamethrin-based pesticide in a volumetric flask using the diluent medium. Nine hundred and ninety (990) ml of water was added to ten (10) ml of deltamethrin and mixed thoroughly to form 1 L of the stock solution through which further dilutions into 0.005, 0.011, 0.022 and 0.044 ppm concentrations were prepared.

### *Experimental design*

The exposure experiment was carried out in a glass tank, arranged in a 5 × 2 Complete Randomized Block Design. A total of two hundred (200) sub-adults of *Clarias gariepinus* were used through-out the study. Prior to the start of the experiment twenty-five (25) sub-adults of the test fish were stocked in each of the tanks containing 50 litres of water and arranged in two replicates. The tanks were arranged to contain a control (0), and the four (4) exposure concentrations (0.005, 0.011, 0.022 and 0.044 ppm) of deltamethrin. The water and test solution in the tanks were renewed every 72 hours, and the test samples fed every 72 hours as well, in order to make available enough blood samples for haematological analysis. The fish were exposed to the different concentrations of deltamethrin for a total of 28 days Fish samples were not fed prior to blood collection. The blood sample for haematological analysis were collected via caudal vein from each fish with 23 G size needle and syringe. Blood samples were preserved in EDTA bottles, before taking to the biochemistry laboratory for analysis. Blood samples for haematological analysis were collected every 7 days and haematological parameters such as; erythrocyte count, haematocrit, haemoglobin content and total protein content in blood plasma, red blood corpuscles, white blood corpuscles, pack cell volume were measured.

### *Haematological analysis*

Fish were anaesthetized in five (5) litres of well-water containing 0.2 g of benzocaine, which had been dissolved in 5 ml acetone. Blood was drawn from the posterior caudal vein according to Schmitt *et al.* (1999) and 2 ml was decanted in heparinized bottles for red blood cell count (RBCC), haematocrit (PCV), haemoglobin (Hb) and white blood cell count (WBCC). Mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were derived from the RBC, PCV and Hb as described by Jain (1986). MCV was calculated in femtoliters = PCV/RBC x 10, MCH was calculated in picograms = Hb/RBC x 10 and MCHC = (Hb in 100mg blood / Hct) x 100.

### *Statistical analysis*

Descriptive statistics (Mean± standard deviation) were carried out on the haematological data obtained. ANOVA was used to test for the significance difference in the changes in haematological parameters between the duration of exposure and also between the different treatment at 0.05 level of

significance. All analysis were carried out using predictive analytical soft-ware (PASW) version 20 and prism graph pad.

## RESULTS

The summary of the alterations in haematological profile of *Clarias gariepinus* exposed to different concentrations of deltamethrin for 28 days is shown in Table 1.

***Red blood cells count (RBC) (x10$^3$) nl***

Deltamethrin induced a significant change ($p<0.05$) in the red blood cells count (RBC) of *Clarias gariepinus* after four weeks of exposure (Table 1). The RBC counts reduced significantly from the control with increase in the concentration of deltamethrin after four weeks of exposure. Following the 28 days exposure period, the RBC count reduced from 4.78±0.19 (control) to 1.51± 0.60 in the highest exposure concentration (0.044ppm) after one week, 5.64±0.04 (control) to 1.45±0.66 after two weeks, 6.61±0.07 (control) to 1.03±0.10 after three weeks and from 8.33±0.04 (control) to 1.36±0.056 after four weeks of exposure (Table 1). The RBC counts increased significantly with increase in the exposure period for the control group ($p<0.05$), but decreased insignificantly with increase in the exposure period across all exposure concentrations (Fig. 2).

***Heamoglobin counts (HGB) (g/dl)***

Deltamethrin toxicity induced significant changes ($p<0.05$) in the HGB count of *Clarias gariepinus* after four weeks of exposure (Table 1). The HGB counts reduced significantly from the control with increase in the concentration of the toxicant for each week of exposure at $p<0.05$. After exposure of *Clarias gariepinus* to deltamethin, the HGB count reduced from 20.75±0.063 in control to 7.76±0.19 in the highest exposure concentration (0.044ppm) after one week, 21.10±0.13 (control) to 6.75±0.21 after two weeks, 22.46±0.22 (control) to 6.15±0.06 after three weeks and from 24.06±0.19 (control) to 6.04±0.05 after four weeks of exposure (Table 1).

The HGB counts increased insignificantly with increase in the exposure period for the control group ($p>0.05$), but decreased insignificantly with increase in the exposure period for the 0.005, 0.011, 0.022 and 0.044ppm group at $p>0.05$ (Fig 3).

***Hematrocrit count (HCT) (%)***

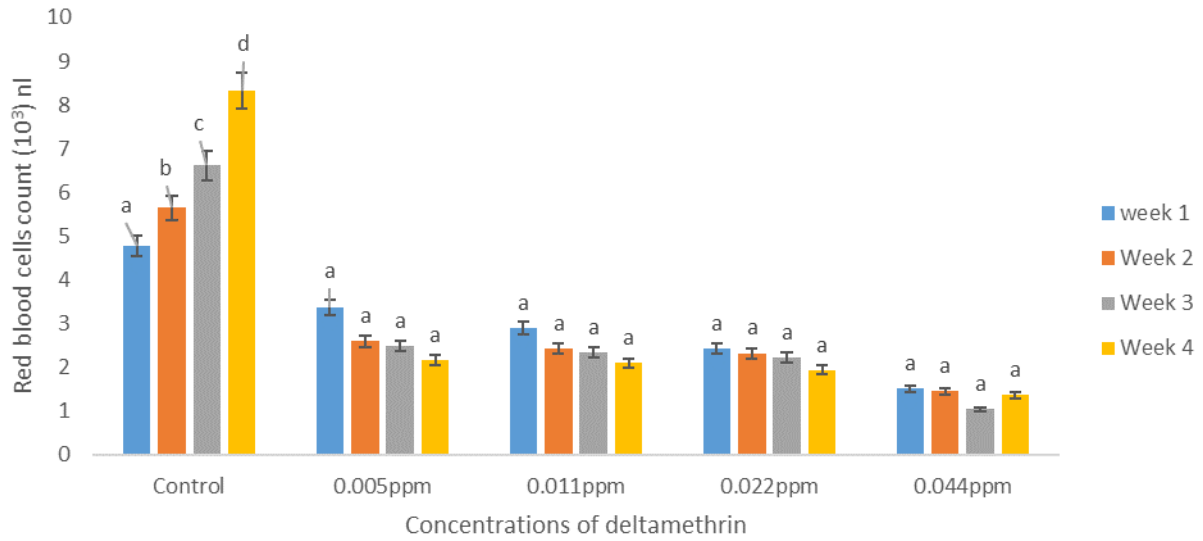
Deltamethrin toxicity induced a significant change ($p<0.05$) in the HCT of *Clarias gariepinus* after four weeks of exposure (Table 1). The HCT counts reduced significantly from the control with increase in the concentration of the toxicant after four weeks of exposure at $p<0.05$. After exposure of *Clarias gariepinus* to deltamethin, the HCT count reduced from 63.740 ± 2.573 (control) to 43.250 ± 0.919 (0.044ppm) after one week, 65.950 ± 1.202 (control) to 41.000 ± 1.131 (0.044ppm) after two weeks, 68.400 ± 1.131 (control) to 39.300 ± 0.989 (0.044ppm) after three weeks and from 69.655 ± 0.784 (control) to 24.200 ± 0.056 (0.044ppm) after four weeks of exposure (Table 1). The HCT counts increased insignificantly with increase in the exposure period for the control group ($p>0.05$), but decreased significantly with increase in the exposure period for the 0.005 and 0.044ppm group at $p<0.05$. The HCT counts also decreased insignificantly with increase in the exposure period for the 0.011 and 0.022ppm group at $p>0.05$ (Fig 4).

**Table 1: Haemathological profile of *Clarias gariepinus* exposed to different concentration of Deltamathrin for 4 weeks**

| S/n | Blood Parameters | Duration (Weeks) | Control | 0.005ppm | 0.011ppm | 0.022ppm | 0.044ppm |
|---|---|---|---|---|---|---|---|
| 1 | RBC (x$10^3$) NL | Week 1 | 4.78 ± 0.190$^a$ | 3.365 ± 0.077$^b$ | 2.905 ± 0.120$^c$ | 2.430 ± 0.042$^d$ | 1.505 ± 0.601$^e$ |
| | | Week 2 | 5.645 ± 0.049$^a$ | 2.590 ± 0.042$^b$ | 2.430 ± 0.070$^c$ | 2.320 ± 0.028$^d$ | 1.450 ± 0.664$^e$ |
| | | Week 3 | 6.610 ± 0.070 $^a$ | 2.490 ± 0.014$^b$ | 2.345 ± 0.021$^c$ | 2.215 ± 0.091$^d$ | 1.035 ± 0.106$^e$ |
| | | Week 4 | 8.330 ± 0.042$^a$ | 2.165 ± 0.063$^b$ | 2.100 ± 0.028$^c$ | 1.935 ± 0.049$^d$ | 1.360 ± 0.056$^e$ |
| 2 | HGB (g/dl) | Week 1 | 20.755 ± 0.063$^a$ | 16.005 ± 0.134$^b$ | 12.755 ± 0.360$^c$ | 8.300 ± 0.141$^d$ | 7.760 ± 0.197$^e$ |
| | | Week 2 | 21.105 ± 0.134$^a$ | 14.310 ± 0.692$^b$ | 12.260 ± 0.056$^c$ | 7.955 ± 0.077$^d$ | 6.750 ± 0.212$^e$ |
| | | Week 3 | 22.460 ± 0.226$^a$ | 11.600 ± 0.028$^b$ | 10.795 ± 0.728$^c$ | 7.715 ± 0.134$^d$ | 6.155 ± 0.063$^e$ |
| | | Week 4 | 24.060 ± 0.197$^a$ | 10.565 ± 0.063$^b$ | 10.355 ± 0.106$^c$ | 7.165 ± 0.120$^d$ | 6.040 ± 0.056$^e$ |
| 3 | HCT (%) | Week 1 | 63.740 ± 2.573$^a$ | 60.105 ± 0.148$^b$ | 56.750 ± 3.040$^c$ | 51.400 ± 1.697$^d$ | 34.250 ± 0.919$^e$ |
| | | Week 2 | 65.950 ± 1.202$^a$ | 48.900 ± 1.838$^b$ | 47.900 ± 0.989$^c$ | 46.800 ± 0.282$^d$ | 41.000 ± 1.131$^e$ |
| | | Week 3 | 68.400 ± 1.131$^a$ | 46.605 ± 0.558$^b$ | 45.105 ± 0.148$^c$ | 43.600 ± 0.565$^d$ | 39.300 ± 0.989$^e$ |
| | | Week 4 | 69.655 ± 0.784$^a$ | 41.500 ± 1.838$^b$ | 39.405 ± 1.704$^c$ | 30.550 ± 3.040$^d$ | 24.200 ± 0.056$^e$ |
| 4 | MCV (FL) | Week 1 | 143.000 ± 1.414$^a$ | 140.000 ± 1.414$^b$ | 136.250 ± 5.303$^c$ | 131.050 ± 1.343$^d$ | 122.000 ± 2.828$^e$ |
| | | Week 2 | 145.350 ± 4.737$^a$ | 118.900 ± 1.838$^b$ | 105.350 ± 6.858$^c$ | 98.950 ± 1.060$^d$ | 96.400 ± 1.697$^e$ |
| | | Week 3 | 146.150 ± 3.464$^a$ | 119.300 ± 1.555$^b$ | 105.500 ± 4.949$^c$ | 91.900 ± 0.989$^d$ | 89.600 ± 1.414$^e$ |
| | | Week 4 | 150.600± 13.859$^a$ | 99.300 ± 1.555$^b$ | 96.400 ± 1.697$^c$ | 89.300 ± 1.555$^d$ | 80.540 ± 0.480$^e$ |
| 5 | MCH (Pg) | Week 1 | 62.950 ± 0.212$^a$ | 61.150 ± 0.919$^b$ | 58.000 ± 1.414$^c$ | 58.300 ± 0.141$^d$ | 56.410 ± 0.438$^e$ |
| | | Week 2 | 69.350 ± 1.626$^a$ | 56.000 ± 2.828$^b$ | 53.000 ± 4.242$^c$ | 42.900 ± 0.424$^d$ | 39.200 ± 1.131$^e$ |
| | | Week 3 | 70.550 ± 1.484$^a$ | 41.700 ± 1.272$^b$ | 37.350 ± 1.202$^c$ | 32.650 ± 0.040$^d$ | 29.300 ± 0.989$^e$ |
| | | Week 4 | 72.200 ± 1.838$^a$ | 36.200 ± 2.828$^b$ | 30.050 ± 0.636$^c$ | 21.100 ± 0.989$^d$ | 14.500 ± 0.989$^e$ |
| 6 | MCHC (g/dl) | Week 1 | 43.550 ± 0.494$^a$ | 43.150 ± 0.919$^b$ | 41.000 ± 1.131$^c$ | 38.505 ± 1.813$^d$ | 29.600 ± 0.848$^e$ |
| | | Week 2 | 44.750 ± 1.202$^a$ | 34.200 ± 5.656$^b$ | 24.300 ± 5.939$^c$ | 22.300 ± 3.181$^d$ | 17.000 ± 1.697$^e$ |
| | | Week 3 | 46.400 ± 2.545$^a$ | 29.050 ± 1.202$^b$ | 25.300 ± 0.919$^c$ | 21.300 ± 0.989$^d$ | 13.150 ± 1.484$^e$ |
| | | Week 4 | 54.800 ± 0.848$^a$ | 20.000 ± 0.565$^b$ | 16.700 ± 2.404$^c$ | 11.750 ± 1.060$^d$ | 9.890 ± 0.862$^e$ |
| 7 | Lymphocytes (%) | Week 1 | 86.455 ± 7.417$^a$ | 74.505 ± 5.225$^b$ | 65.105 ± 0.147$^c$ | 62.950 ± 0.636$^d$ | 43.350 ± 0.777$^e$ |
| | | Week 2 | 87.400 ± 1.697$^a$ | 70.150 ± 0.494$^b$ | 60.800 ± 1.697$^c$ | 42.600 ± 3.679$^d$ | 40.150 ± 0.494$^e$ |
| | | Week 3 | 94.350 ± 2.192$^a$ | 60.500 ± 2.828$^b$ | 54.200 ± 5.656$^c$ | 41.750 ± 1.202$^d$ | 33.100 ± 3.252$^e$ |
| | | Week 4 | 98.150 ± 3.747$^a$ | 51.750 ± 1.202$^b$ | 39.400 ± 1.697$^c$ | 29.350 ± 1.767$^d$ | 22.000 ± 8.485$^e$ |
| 8 | PLT ($10^3$/Nl) | Week 1 | 72.750 ± 3.889$^a$ | 53.700 ± 0.707$^b$ | 38.050 ± 0.353$^c$ | 36.500 ± 0.070$^d$ | 28.000 ± 1.272$^e$ |
| | | Week 2 | 75.700 ± 4.525$^a$ | 51.400 ± 0.494$^b$ | 28.050 ± 3.646$^c$ | 23.950 ± 0.919$^d$ | 21.000 ± 0.848$^e$ |
| | | Week 3 | 79.200 ± 1.414$^a$ | 60.500 ± 0.848$^b$ | 23.200 ± 2.121$^c$ | 19.550 ± 1.343$^d$ | 13.850 ± 2.333$^e$ |
| | | Week 4 | 82.200 ± 2.828$^a$ | 43.400 ± 2.545$^b$ | 19.760 ± 1.202$^c$ | 15.350 ± 1.626$^d$ | 11.000 ± 1.131$^e$ |
| 9 | WBC (x$10^3$/Nl) | Week 1 | 95.310 ± 4.398$^a$ | 87.735 ± 2.071$^b$ | 55.215 ± 0.982$^c$ | 45.710 ± 1.569$^d$ | 37.720 ± 1.697$^e$ |
| | | Week 2 | 98.500 ± 1.555$^a$ | 81.650 ± 1.060$^b$ | 50.000 ± 0.565$^c$ | 40.600 ± 2.828$^d$ | 31.500 ± 1.414$^e$ |
| | | Week 3 | 101.500 ± 1.414$^a$ | 78.850 ± 0.353$^b$ | 44.500 ± 2.828$^c$ | 37.800 ± 3.111$^d$ | 25.600 ± 8.848$^e$ |
| | | Week 4 | 120.900 ± 3.252$^a$ | 67.500 ± 2.404$^b$ | 39.800 ± 0.989$^c$ | 31.900 ± 4.666$^d$ | 21.250 ± 1.767$^e$ |

Values are in Mean ± Standard deviation

*Means with different superscript within the same rows for each week are significantly different at P<0.05




*Bars with different superscript are significantly different between each week of exposure for the different concentrations of deltamethrin at p<0.05
Fig 2: Red blood cells (RBC) profile of *Clarias gariepinus* exposed to deltamethrin

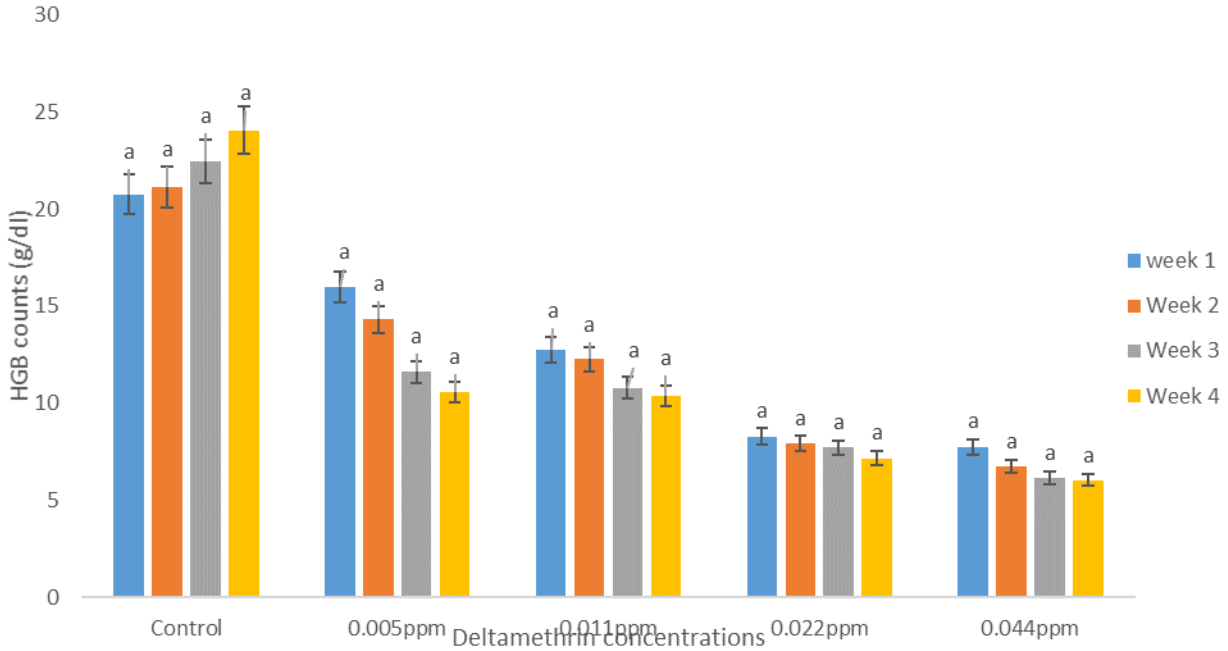
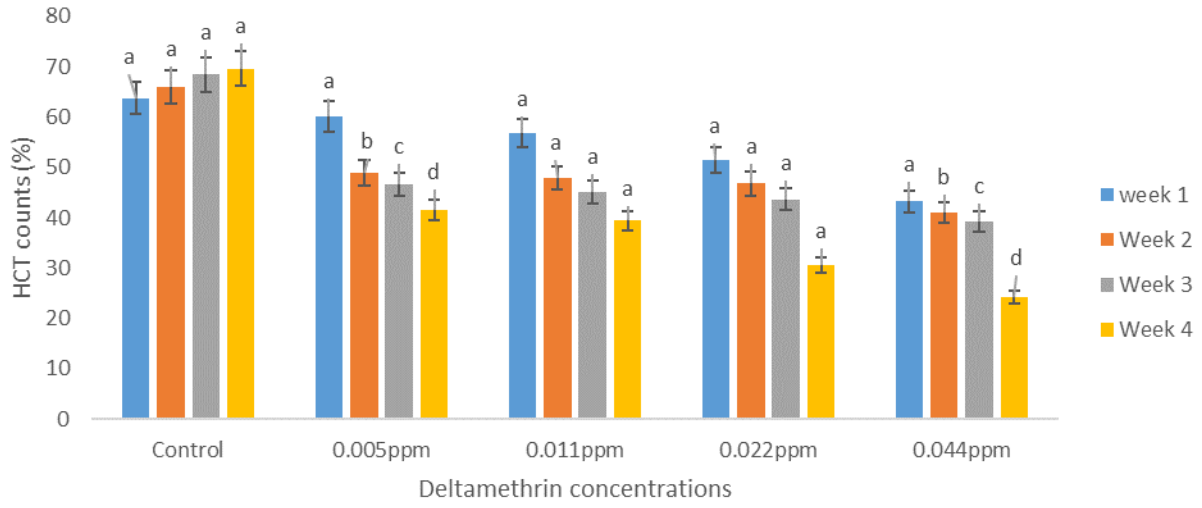
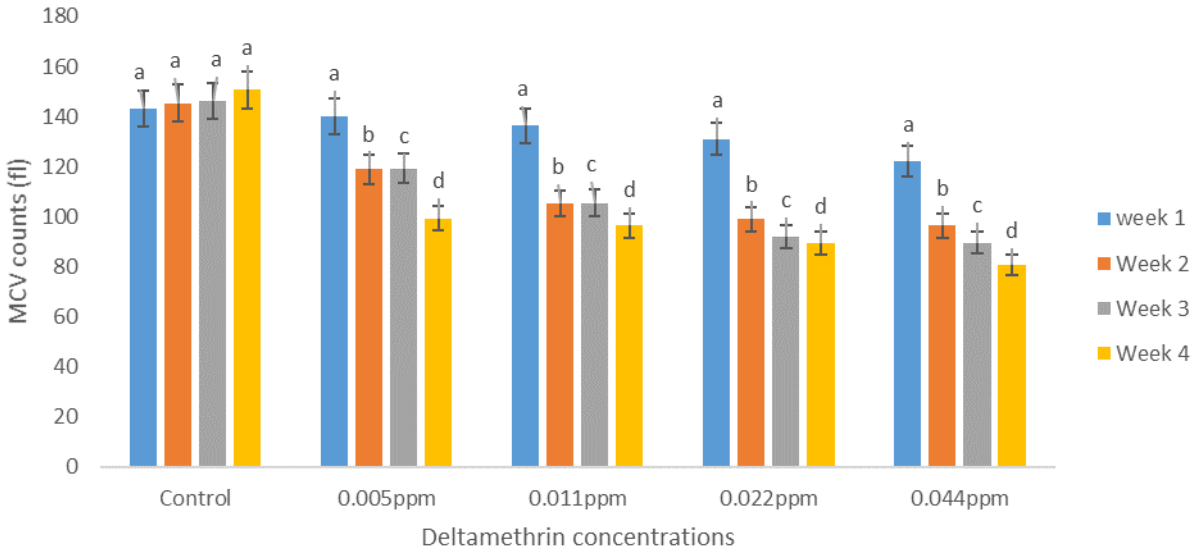


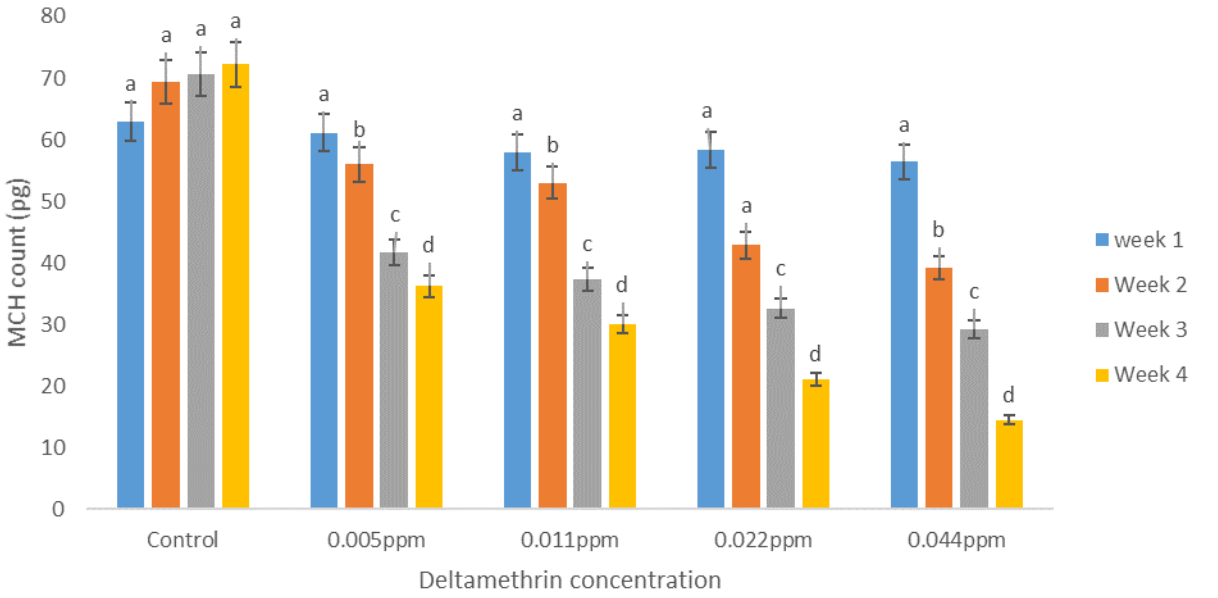

Fig 3: Haemoglobin (HGB) profile of *Clarias gariepinus* exposed to deltamethrin
*Bars with different superscript are significantly different between each week of exposure for the different concentrations of deltamethrin at p<0.05




*Bars with different superscript are significantly different between each week of exposure for the different concentrations of deltamethrin at p<0.05
Fig 4: Hematocrit (HCT) profile of *Clarias gariepinus* exposed to deltamethrin

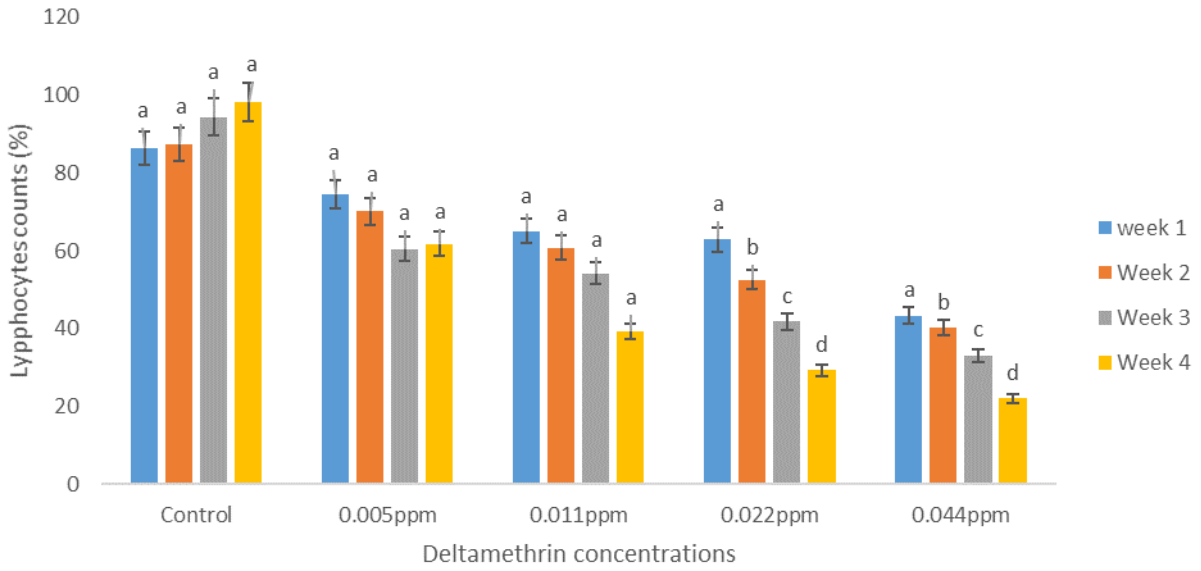



*Bars with different superscript are significantly different between each week of exposure for the different concentrations of deltamethrin at p<0.05
Fig 5: Mean corpuscular volume (MCV) profile of *Clarias gariepinus* exposed to deltamethrin



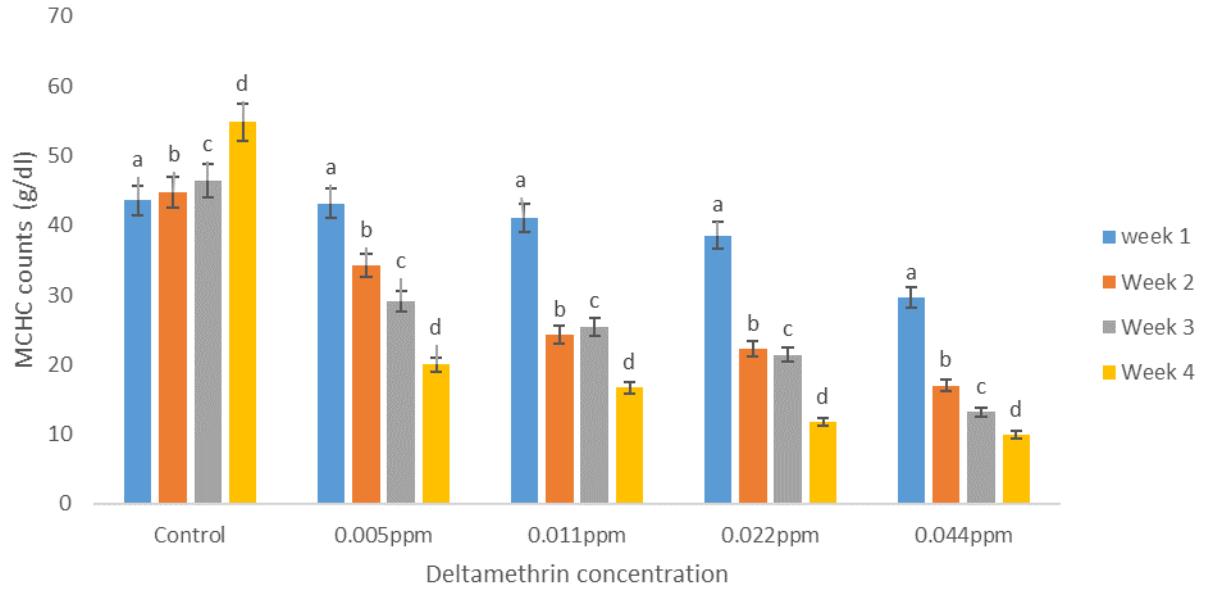

*Bars with different superscript are significantly different between each week of exposure for the different concentrations of deltamethrin at p<0.05

**Fig 6:** Mean cell haemoglobin (MCH) profile of *Clarias gariepinus* exposed to deltamethrin



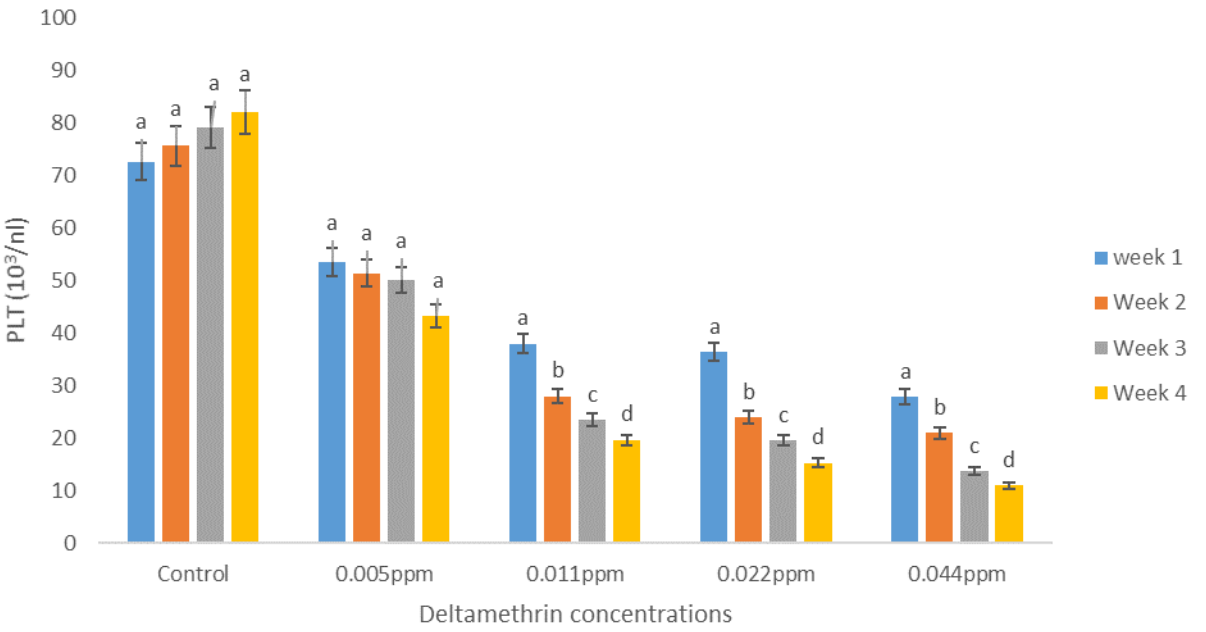

*Bars with different superscript are significantly different between each week of exposure for the different concentrations of deltamethrin at p<0.05

Fig 7: Mean cell haemoglobin concentration (MCHC) profile of *Clarias gariepinus* exposed to deltamethrin



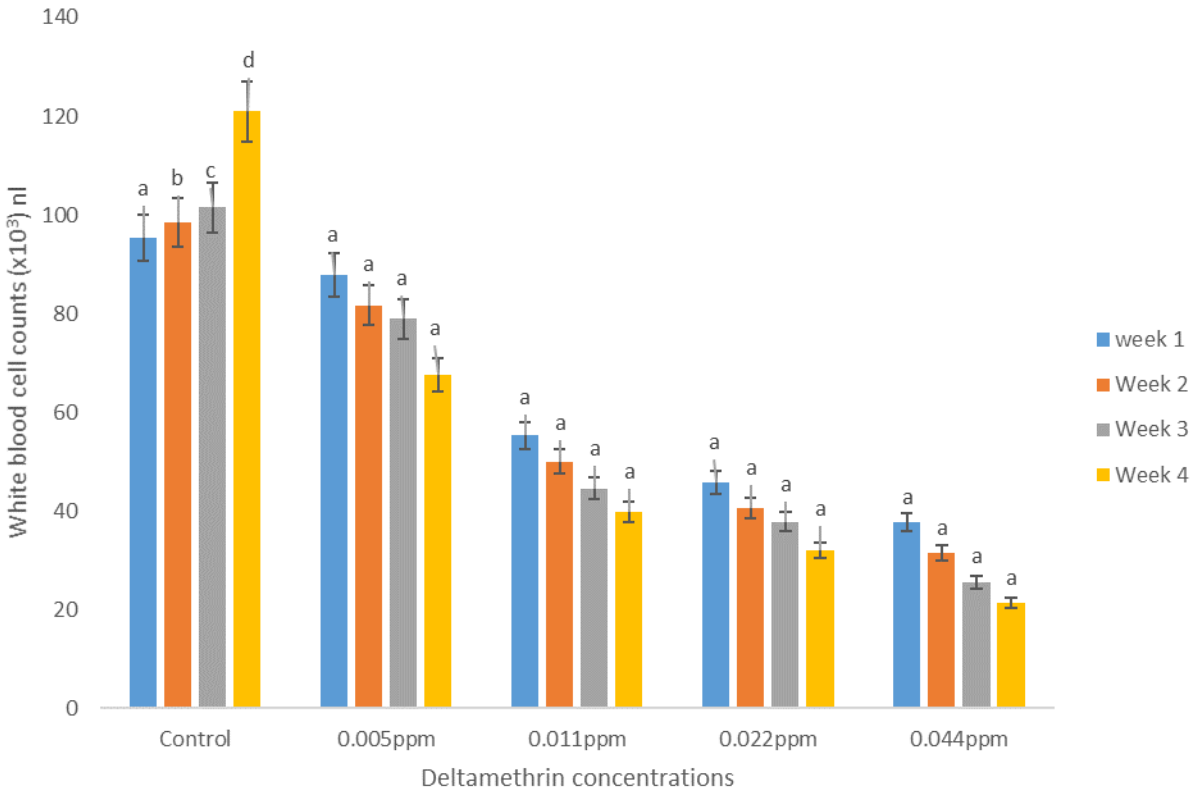

*Bars with different superscript are significantly different between each week of exposure for the different concentrations of deltamethrin at p<0.05

Fig 8: Lymphocytes profile of *Clarias gariepinus* exposed to deltamethrin




*Bars with different superscript are significantly different between each week of exposure for the different concentrations of deltamethrin at p<0.05

Fig 9: Platelet counts (PCT) profile of *Clarias gariepinus* exposed to deltamethrin




*Bars with different superscript are significantly different between each week of exposure for the different concentrations of deltamethrin at p<0.05
Figure 10: White blood cells (WBC) profile of *Clarias gariepinus* exposed to deltamethrin

***Mean corpuscular volume (MCV) (fl)***
Deltamethrin toxicity induced a significant change (p<0.05) in the MCV count of *Clarias gariepinus* after four weeks of exposure (Table 1). The MCV counts reduced significantly from the control with increase in the concentration of the toxicant for each week of exposure at p<0.05. After exposure of *Clarias gariepinus* to deltamethin, the MCV count reduced from 143.000 ± 1.414 (control) to 122.000 ± 2.828 (0.044ppm) after one week, 145.350 ± 4.737 (control) to 96.400 ± 1.697 (0.044ppm) after two weeks, 145.150 ± 3.464 (control) to 89.600 ± 1.414 (0.044ppm) after three weeks and from 150.600 ± 13.859 (control) to 80.540 ± 0.480 (0.044ppm) after four weeks of exposure (Table 1). The MCV counts increased insignificantly with increase in the exposure period for the control group (p>0.05), but decreased significantly with increase in the exposure period for the 0.005, 0.011, 0.022 and 0.044ppm group at p<0.05 (Fig 5).

***Mean cell haemoglobin (MCH) (pg)***
Deltamethrin toxicity induced significant changes in the MCH count of *Clarias gariepinus* after four weeks of exposure (Table 1). The MCH counts reduced significantly from the control with increase in the concentration of the toxicant for each week of exposure at p<0.05.

After exposure of *Clarias gariepinus* to deltamethin, the MCH count reduced from 62.950 ± 0.212 (control) to 56.410 ± 0.438 (0.044ppm) after one week, 69.350 ± 1.626 (control) to 39.200 ± 1.131 (0.044ppm) after two weeks, 70.550 ± 1.484 (control) to 29.300 ± 0.989 (0.044ppm) after three weeks and from 72.200 ± 1.838(control) to 14.500 ± 0.989 (0.044ppm) after four weeks of exposure (Table 1). The MCH counts increased insignificantly with increase in the exposure period for the control group (p>0.05), but decreased significantly with increase in the exposure period for the 0.005, 0.011, 0.022 and 0.044ppm group at p<0.05 (Fig 6).

***Mean cell haemoglobin concentration (MCHC) (g/dl)***
Deltamethrin toxicity induced significant changes in the MCHC count of *Clarias gariepinus* after four weeks of exposure (Table 1). The MCHC counts reduced significantly from the control with increase in the concentration of the toxicant for each week of exposure at p<0.05. After exposure of *Clarias gariepinus* to deltamethin, the MCHC count reduced from 43.550 ± 0.494 (control) to 29.600 ± 0.848 (0.044ppm) after one week, 44.750 ± 1.202 (control) to 17.000 ± 1.697 (0.044ppm) after two weeks, 46.400 ± 2.545 (control) to 13.150 ± 1.484 (0.044ppm) after three weeks and from 54.800 ± 0.848

(control) to 9.890 ± 0.862 (0.044ppm) after four weeks of exposure (Table 1). The MCHC counts increased significantly with increase in the exposure period for the control group ($p<0.05$), but decreased significantly with increase in the exposure period for the 0.005, 0.011, 0.022 and 0.044ppm group at $p<0.05$ (Fig 7).

***Lymphocytes count (%)***

Deltamethrin toxicity induced changes in the lymphocytes of *Clarias gariepinus* after four weeks of exposure (Table 1). The lymphocytes counts reduced significantly from the control with increase in the concentration of the toxicant after four weeks of exposure at $p<0.05$. After exposure of *Clarias gariepinus* to deltamethin, the count reduced from 86.455 ± 7.417 (control) to 43.350 ± 0.777 (0.044ppm) after one week, 87.400 ± 1.697 (control) to 40.150 ± 0.494 (0.044ppm) after two weeks, 94.350 ± 2.192 (control) to 33.100 ± 3.252 (0.044ppm) after three weeks and from 98.150 ± 3.747 (control) to 22.000 ± 8.485 (0.044ppm) after four weeks of exposure (Table 1). The lymphocytes counts increased insignificantly with increase in the exposure period for the control group ($p>0.05$), but decreased insignificantly with increase in the exposure period for the 0.005, 0.011 and 0.044ppm group at $p>0.05$. The HCT counts also decreased significantly with increase in the exposure period for the 0.022ppm group at $P<0.05$ (Fig 8).

***Platelet counts (PLT) count ($10^3$/nl)***

Deltamethrin toxicity induced significant changes in the PLT of *Clarias gariepinus* after four weeks of exposure (Table 1). The PLT counts reduced significantly from the control with increase in the concentration of the toxicant after four weeks of exposure at $p<0.05$. After exposure of *Clarias gariepinus* to deltamethin, the count reduced from 72.750 ± 3.889 (control) to 28.00 ± 1.272 (0.044ppm) after one week, 75.700 ± 4.525 (control) to 21.000 ± 0.848 (0.044ppm) after two weeks, 79.200 ± 1.414 (control) to 13.850 ± 2.333 (0.044ppm) after three weeks and from 82.200 ± 2.828 (control) to 11.000 ± 1.131 (0.044ppm) after four weeks of exposure (Table 1). The PLT counts increased insignificantly with increase in the exposure period for the control group ($p>0.05$), but decreased significantly with increase in the exposure period for the 0.011, 0.022 and 0.044ppm group at $p<0.05$. The PLT counts also decreased insignificantly with increase in the exposure period for the 0.005ppm group at $p>0.05$ (Fig 9).

***White blood cells counts (WBC) (X103) nl***

Deltamethrin toxicity induced significant changes in the white blood cells (WBC) count of *Clarias gariepinus* after four weeks of exposure (Table 1). The WBC counts reduced significantly from the control with increase in the concentration of the toxicant for each week of exposure at $p<0.05$. After exposure of *Clarias gariepinus* to deltamethin, the WBC count reduced from 95.310 ± 4.398(control) to 37.720 ± 1.697 (0.044ppm) after one week, 98.500 ±1.555 (control) to 31.500 ± 1.141 (0.044ppm) after two weeks, 101.500 ± 1.414 (control) to 25.600 ± 8.848 (0.044ppm) after three weeks and from 120.900 ± 3.252 (control) to 21.250 ± 1.767 (0.044ppm) after four weeks of exposure (Table 1). The WBC counts increased significantly with increase in the exposure period for the control group ($p<0.05$), but decreased insignificantly with increase in the exposure period for the 0.005, 0.011, 0.022 and 0.044ppm group at $p>0.05$ (Fig 10).

## DISCUSSION

The wide use of chemicals to control pest has been recognized in the world and the benefit that these chemicals have brought remarkable testimonies to technological advancement in terms of increased food production and economical gains (Adelowa, 2004). The widespread and indiscriminate use of these synthetic pyrethroid pesticides have led to serious ecosystem problems, especially water and soil pollution. Pesticide pollution has become a significant subject of discussion globally (Inyang, 2013), and because fish is in close association with the aquatic environment, changes in this environment would be reflected in alterations in their haematological profile (Golemi *et al*., 2012). Haematological parameters reflect the poor condition of fish more quickly than other commonly measured parameters, and are widely used for the description of healthy fish and for monitoring stress responses (Thrall, 2004; Pimpao *et al*., 2007). A change in haematological parameters is good procedure for quick assessment of the impacts of toxicant on fish (Ololade and Oginni 2010; Docan et al., 2018).

In this study, we showed that exposure of *Clarias gariepinus* to deltamethrin resulted in a significant alteration in the haematological profile, and this could be due to its high rate of gill adsorption as a result of the lipophilicity of deltamethrin (Elells *et al*., 1995). Significant haematological changes were induced by deltamethrin in *Clarias gariepinus* after four weeks of exposure, and this was similar to the findings of Jayaprakash *et al*. (2013), who also reported the adverse effect of deltamethrin on the hematology of the freshwater fish. The alteration of the different haematological profile of the fish was concentration and exposure duration dependent, decreasing with increase in concentrations and duration of exposure. The RBC, HGBC, HCT, MCV, MCH, MCHC, lymphocytes, PLT and WBC decreased significantly form the control, as the concentration increases, and similar observations were reported by Jayaprakash *et al*. (2013), while studying the changes in some hematological parameters of *Channa punctatus* exposed to different concentrations of deltamethrin; El-Sayed and Saad (2007); Svobodova *et al*., (2003) for carp; Sayeed *et al*., 2003 for *Heteropneustes fossilis*; Nwani *et al*., (2015) while studying physiological effect of paraquat in juvenile *Clarias gariepinus* and Adeyemo (2007) while studying the haemathological profile of *C. gariepinus* exposed to lead.

The significant decrease in the WBC compared to the control observed in the present study is contrary to the findings of Nwani *et al*., (2015) who reported a significant increase in white blood cell. This differences in the profile of WBC between the two studies could be due to the difference in fish species, age, the cycle of sexual maturity and health condition of the fish (Vaiyanan *et al*., 2015, Luskova, 1997). The alterations in the haematological parameters of the fish compared to the control could be due to a decline in the haematopoiesis, increased permeability of the surface membrane of erythrocytes exposed to deltamethrin and further release of haemoglobin (El-sayed and Saad, 2007), generation of reactive oxidation stress due to the toxicant, which impose severe oxidative stress on the fish (Pereira *et al*., 2013).

It was also observed that the haematological parameters decreased for each exposure group (each concentration) with increase in the duration of exposure of the fish, except in the control group which increased with increase in the duration of the experiment. The reduction in the haemathological parameters of the group exposed to toxicants with weeks of exposure could be due to the generation of reactive oxidation stress which imposes oxidative stress on the fish (Pereira *et al*., 2013) or weekly increase in the permeability of the surface membrane of erythrocytes exposed to deltamethrin and release of haemoglobin (El-sayed and Saad, 2007).

## CONCLUSION

In conclusion, we have demonstrated that exposure of subadult *Clarias gariepinus* to sublethal concentrations of deltamethrin resulted in a significant alteration in the haematological profile of fish suggesting that the contaminants may have negative physiological effects on other non-target organisms and wildlife.

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