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Condition Factor, Organosomatic Indices and behavioural Abnormalities of *Clarias gariepinus* exposed to Lambda Cyhalothrin

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ABSTRACT

The aim of this study was to unveil the effect of Lambda Cyhalothrin on condition factor, organosomatic indices and behavioural abnormalities of *Clarias gaiepinus* (a common Niger Delta Wetland fish). Twenty eight (28) adult *Clarias gariepinus* (mean length 16.50±0.12cm and mean weight 42.2±0.10g) were acclimatized to laboratory condition for 7 days and then exposed to varying sublethal concentration of Lambda Cyhalothrin (o.012, 0.024, and 0.036mgl^{-1}) in a semi static bioassays for 14 days. Fish were measured and weighed prior and at the experiment. Additionally, keen observation of fish behaviour before and after exposure to the toxicant was also done on daily basis. The final condition of the fishes dropped drastically at increased toxicant concentration (in a dose dependent pattern). Organosomatic indices of the liver (Hepasomatic index {HIS}), kidney (Renasomatic index {RSI}) and spleen (Spleenosomatic index {SSI}) values showed significant variation ($p<0.05$). HIS values increases in a dose dependent pattern while SSI decreases in a dose dependent pattern. RSI values showed no significant variation ($P>0.05$) except at 0.012mgl^{-1}. The results clearly unveiled the effect of Lambda Cyhalothrin on *Clarias gariepinus.* These parameters could serve as biomarkers for effect of this toxicant on aquatic organisms. The use of this toxicant in the environment should be done with caution.

Keywords: *Clarias gariepinus,* Lambda Cyhalothrin, Organosomatic indices, bioassay, condition factor.

INTRODUCTION

Pesticide problems in the environment

Pesticides are broadly used in agriculture, and their remains end up in the aquatic environment via various means including improper disposal of pesticide container and careless spraying approach (Inyang et al., 2016a-c, 2017). They can be transferred via food chain to fish, shell fish and ultimately reach humans. Pesticides are also used directly in aquaculture to control the ectoparasites and insects in nursery and grow out systems (Pittenger, 2002). The development of industrial and agricultural activities contributes enormously to the increase of contaminants in the aquatic ecosystems (Inyang et al., 2016a). Besides toxicological effects, pesticides could lead to changes in water and sediment quality, which could have adverse effect on health of biodiversity (especially fisheries) found in such environments and humans (Pittenger, 2002). According to World Health Organization (WHO), approximately 3 million pesticide poisoning incidence occurs per annum, which could lead to about 250,000 deaths (Deng and Yang, 2007). Despite this alarming figure, there is global system at present to tract and stem poisoning or diseases associated with pesticide use (Ali and Chia, 2008; Aly and El-Gendy 2014; Uchendu et al., 2012). Irrespective of the source of toxicant, it will end up in the aquatic ecosystem (Ajani and Awogbade, 2012). This is because the pollutant in the form of aerosol is washed down to the soil via rainfall which finds its way to the aquatic ecosystem via runoff in addition to other soil contaminants.

Lambda Cyhalothrin

Lambda Cyhalothrin is a pyrethroid insecticide (Inyang et al., 2016d, 2017). Pyrethroids are synthetic chemical analogues of pyrethrins, which are naturally occurring insecticide compounds produced in the flowers of *Chrysanthemum Cineraiaefolum* (Inyang et al., 2016d, 2017). Insecticidal products containing pyrethroids have been widely used to control insect pest in agriculture, public health and gardens (Anweg and Weston, 2005, Oros and Werner, 2005).

Pyrethroids are important where applications are made to control cockroaches, mosquitoes, ticks and flies, which may act as disease vectors (Anweg and Weston, 2006). Residential use of parathyroid products has increased because of the suspension of organophosphate products containing chloropyrifos and diazinon (Oros and Werner, 2005).

Significantly residues of Lambda Cyhalothrin have been reported in irrigation and storm run-off resulting from agricultural applications and anthropogenic releases. For example, Lambda Cyhalothrin was detected in water at 0.11 – 0.14μgl^{-1} from agricultural watersheds in Stanislaus country, California (Sterner, 2009). In Nigeria, its usage is moderate and it is sold in an open market.

Toxicity test conducted at levels of Lambda Cyhalothrin residues measured in water sediment unveiled its potential effect on aquatic organisms including fish and amphipods (Gu et al., 2007). Changes in body condition especially weight is a major indicator used to assess the adverse effects of drugs and chemicals (Aly and El-Gendy 2014). Again, changes in organ weight are also used to assess response to chemicals in toxicological studies (Mukinda and Eagles 2010). As such, these organs are used as biomarker on fisheries exposed to xenobiotics.

A biomarker, according to Depledge (1994) may be any measurable biochemicals, cellular and physiological or behavioural change in organism or population that indicates exposure to chemical pollutants.

The aim of this present work was to evaluate the effect of Lambda Cyhalothrin on organs (organosomatic index), condition factor of *Clarias garipinus* and behavioural responses during the exposure period. These parameters can be used as potential biomarkers of damage caused by Lambda Cyhalothrin exposure.

MATERIALS AND METHODS

The Probe Organism

The fish samples used for the experiment were purchased from a private fish farm in Yenagoa, Bayelsa State. The fish sample was conveyed to the Department of Biological Sciences (Ecotoxicology Unit), Niger Delta University in a 50 litre plastic container with the pond water which was covered with a net to avoid jumping out. Twenty eight (28) adult healthy *Clarias gariepinus* (with mean weight 42.20±0.1g, mean length 16.50±0.12cm) were acclimatized individually in a 40 litre circular aquaria for two weeks. Fish were fed once a day at 11.00hrs with 35% crude protein diet at 1% biomass.

General Bioassay Technique

Sublethal concentrations of Lambda Cyhalothrin for the assay (0.012, m0.024, 0.036ppm) in addition to control (0.000ppm) were evaluated based on the range finding test previously reported by Inyang (2008). These were prepared by transferring 0.01, 0.02, 0.03 mls with borehole water in the test aquaria. About 30L of the diluents (borehole water) was used as control. Replicates of each treatment level (concentration) or experimental group and control were set up by introducing fishes individually into each aquarium. The experiment lasted for 2 weeks (14 days) during which the exposure media was renewed every 24 hrs. The physio-chemical characterization of the water used for fish bioassay was carried out using standard methods of APHA (1998) and the following values were obtained: temperature 35.00 – 25.13^{0}C, pH 6.20 – 6.35, alkalinity, 12.44 – 17.88mgl^{-1}, conductivity 99.30 – 136.12µs/cm, dissolve oxygen 5.07 – 7.21mgl^{-1} and turbidity 0.23 – 0.50NTU.

Condition factor and organosomatic index

In all individuals total length, standard length and body mass were determined. Fulton's condition factor was used for the analysis:

Fulton's condition factor (K) were calculated by using the formula:
$K = W \times 100/L^3$
W = weight of the fish (g)
L = Standard length of the fish (Akombo et al., 2013).

After that, the liver, heart, spleen and kidney were carefully removed and weighed. Organosomatic indices for the probe organism were calculated as follows

Organosomatic Index (OSI) = [weight of the organ (g)/ weight of fish (g)] x 100 (Inyang, 2008)

Fish Behaviour

Before subjecting the fish to the toxicant, the fish swimming movement rate was keenly observed and also the behaviour and body of the fishes were observed. These observations were used for the control and provided a baseline with which to compare treatments.

Statistical analysis

Statistical analysis was carried out using statistical package for social sciences software version 20. Data were expressed as mean ± standard error; one way analysis of variance was carried out at $\alpha = 0.05$ and turkey HSD statistics was used for multiple comparison.

RESULTS AND DISCUSSION

Condition factor

The condition factor which reflects the overall wellbeing or plumpness of fish in the present experiment unveiled a slight decrease in values as the concentration of the toxicant increases in a dose dependent pattern compared to the initial condition. The exposure of *Clarias gariepinus* showed the effect of the xenobiotics on the probe organism wellbeing. Condition factor and organosomatic indices are typically used in investigating the health of the fish (Hoque et al., 1998; Seiyaboh et al., 2016a-c). Since many levels of processes in the organism are involved at various levels of organization, indices like Fulton's condition factor can indicate nutritional status of individuals and health status of the fisheries (Adam's et al., 1992). Toxic chemical as well as poor nutrition can altar fish plumpness in any aquatic environment.

Table 1: Condition factor and organosomatic indices of *Clarias gariepinus* exposed to Cyhalothrin for 14 days (mean ± S.D)

Conc. Of Cyhalothrin (mgl^{-1})	Initial condition	Final Condition	Hepatosomatic index (Liver)	Cardiosomatic index (Heart)	Renasomatic Index (Kidney)	Splenosomatic Index (Spleen)
0.00	0.64±0.00^{a}	0.65±0.01^{a}	13.48±0.01^{bc}	2.26±0.02^{a}	6.38±0.00^{b}	3.42±0.00^{aa}
0.012	0.63±0.00^{a}	062±0.00^{ab}	25.46±0.20^{a}	2.32±0.20^{a}	9.64±0.07^{a}	2.41±0.00^{a}
0.024	0.66±0.10^{a}	0.58±0.00^{ab}	18.45±0.12^{b}	2.30±0.03^{a}	6.76±0.08^{b}	1.12±0.02^{b}
0.036	0.66±0.02^{a}	0.50±0.10^{b}	16.76±0.12^{b}	2.28±0.02^{a}	6.50±0.01^{b}	1.03±0.02^{b}

Means with the same superscript within the column are not significantly different ($p>0.05$)

Organosomatic indices

Hepatosomatic (HIS) values were significant ($p<0.05$) within the experimental group. Values decreased as the concentration of Cyhalothrin increased (in a dose dependent pattern). The reverse was the case of cardiosomatic index (CSI). Values of CSI increased as the levels of the toxicant increased in a dose dependent pattern. Renatosomatic index (RSI) values were not significant ($p>0.05$) while a decrease in values of spleenosomatic index (SSI) were significant akin to HIS.

Organosomatic indices can be described as the ratio of organ to body weight, when the organs are measured in relation to body mass it can be directly linked to some environmental changes (Ronald and Bruce, 1990). It is revealed through variation in size, and as such influenced by environmental factors (Dekic et al., 2016). Size and weight of the liver, gonads, spleen, heart, among others are related to the length and weight of the fish and indicate the general status of health of the fish (Dekic et al., 2016).

A decrease in values of HIS is an indication of an adverse effect on the fish's liver. This result is akin to the result obtained by Edori (2007) when he exposed *Clarias gariepinus* to Monoclotophos (an organophosphate insecticide). Liver is responsible for enzymatic decontamination process, vitellogenin production and storage of glycogen as energy reserves, alteration of its function will affect the fish severely (Jenkin, 2004). Statistically significant values were obtained in SSI. A drop in values in a dose dependent pattern characterized SSI, quite unlike Gabriel et al. (2009) when they exposed *Clarias gariepinus* to extract of *Lepidagathis alopecuroides.* The result the authors obtained shows an increase in SSI as the concentration of the toxicant increases.

The spleen produces Leukocytes, serves as a storage space for Red Blood Cells and destroys worn out red blood cells (Miller and Harley, 2004), any slight aberration from this function will surely affect the fish physiological functions. Changes in the size of the spleen may be a sign of dysfunction that affects the general health of the individual (Dekic et al., 2016). Reduction of the size of the spleen can be in connection with acute nonspecific stresses, as well as with a number of chronic exposures to chemical contaminants, which are responsible for the necrosis and changes in cellular process (Yamamoto, 1987; Randall and Perry, 1992).

Kidney somatic index (kenatosomatic index) values fluctuate within the experimental group compared to control. Values were not statistically significant (p>0.05) at 0.01mgl^{-1} (albeit not in dose dependent pattern) as the concentration of the toxicant increases. According to Jenkins (2004) and Singh (1982), kidney is part of hematopoietic (blood producing) tissue in fish. Additionally, kidney is also involve in blood filtration, the development of new blood cells and the immunological interactions, hence increase or decrease in their size may indicate a pathological response to the xenobiotic.

The cardiosomatic index (CSI) values were not significant (p>0.05), an indication that the xenobiotic did not have any effect on the heart tissues.

Behavioural abnormalities

The exposed fish (*Clarias gariepinus)* showed initial responses such as gasping for air, erratic swimming loss of movement cor-ordination and general hyper-sensitivity especially at the highest concentration of Cyhalothrin. Similar findings have been reported by several workers in a number of fish species including *Clarias gariepinus, Heterobranchus bidorsalis,* Common Carp (*Cyprinus carpio and Branchydario rerio* (Omerigie and Okpanachi 1995, Svobodova et al., 2001; Edori, 2007; Inyang, 2008). The stressful behavioural responses of the fish suggest that they suffered respiratory impairment due to the effect of the toxicant precisely on the gills and general metabolism (Inyang, 2008). The observed accumulation of mucus in some fishes (mostly, fishes exposed to the toxicant at increased concentration) was a clear indication of the poisoning effect of Cyhalothrin on organs, glands and tissues as confirmed from studies of Inyang (2008).

Exposure of fishes to Cyhalothrin was observed to cause fatigue as the concentration of the toxicant increases. The fatigue may due to excessive utilization of energy substances such as carbohydrate, protein and lipid (Uminger, 1977)

CONCLUSION

Our experiment was significant because little is known about the organosomatic indices of *Clarias gariepinus.* Additionally, the concentration that caused these changes was much lower than anticipated. This shows that anywhere that insecticide runoff is present, it is possible that the organism in that microenvironment will suffer negative effects from exposure to even low levels lambda cyhalothrin. The use of this toxicant in the environment should be done with caution.

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