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Organosomatic Indices and Condition Factor of *Clarias gariepinus* (Burchell, 1822) Sub-Adult Exposed to Commercial Paraquat

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Abstract:- An investigation on the effect of paraquat on organosomatic indices and condition factor of *Clarias gariepinus* sub-adult was carried out. Thirty six *C. gariepinus* (weight, 362.64 ± 95.88g; length, 37.65 ± 2.85cm) sub adult were exposed in a static renewal, triplicate design to control (no added paraquat) or 552mg/l paraquat in intermittent (two days exposed and two days in clean water alternately) and continuous exposures for 14 days. The result showed a transient significant (ANOVA, p>0.05) increase in the continuous exposure compared to the intermittent exposure and control for Hepatosomatic index (HSI) on day 7. However, at the end of the experiment there were no significant treatment effects in the gills-somatic index (GSI), Hepatosomatic index (HSI) and renasomatic index (RSI). On day 7, there was no significant treatment effect in the condition factor (Fulton's K) however, on day 14 the intermittent and continuous exposures showed significant decreases compared to the control, values (mean ± STD) were 0.60 ± 0.05, 0.51± 0.07, 0.49 ± 0.08. In conclusion, exposure of commercial paraquat to *C. gariepinus* did not affect the organosomatic index but resulted in poor condition factor especially during continuous exposure.

Keywords:- *Hepatosomatic Index (HSI), Renatosomatic Index (RSI), Gills-Somatic Index (GSI), Pesticides, Continuous Exposure.*

I. INTRODUCTION

Organosomatic index is the ratio of organ to body weight (Ronald and Bruce 1990). Organosomatic index can be linked to effects of chemical on target organs like the gills, liver and kidney (Guillo and Hinton 2008) as well as used as indices of change in nutritional and energy status (Maxwell and Dutta 2005). Organosomatic index and condition factor of fish is one way to assess the general health of fish (Ariweriokuma *et al*., 2011) and monitor the influence of environmental factors on fish (Dekić *et al*., 2016). Organosomatic indices used in stress-related studies included: hepatosomatic index (HSI), renatosomatic index (RSI), gills-somatic index (GSI), viscerosomatic index (VSI), spleenosomatic index (SSI) and cardiosomatic index (CSI). Several studies on organosomatic indices are in the literatures, for example Edori *et al*. (2013) worked on liver, heart, kidney and spleen of *C. gariepinus* after 21 days exposure to paraquat at 0.00, 2.00, 4.00, 6.00 and 8.00 mg/l concentrations and reported a slight increase in the liver size while the kidney, spleen and heart slightly decreased at the various concentrations. Ogamba *et al*. (2014) worked on the effect of dichlorvos on the organosomatic index: cardiosomatic, hepatosomatic, renatosomatic and spleenosomatic indices of *C. gariepinus* exposed to sublethal concentration of 0.30, 0.40, 0.50 and 0.60 ppm and reported no significant (p>0.05) difference in the organosomatic indices.

Paraquat is commonly used in Nigeria in agricultural farms to control plants. Most of the reports on paraquat toxicity on fish have focused on early life stages for example Arivu and Jiyavudeen, (2016); Banaee *et al*. (2013) and Ladipo *et al.* (2011), there are few information in the literatures on sub-adult (Edori *et al*., 2013). In Nigeria, catfish is the most abundant cultured fish species (Amachree *et al*., 2019). *Clarias gariepinus* was selected for this experimental study because of its commercial importance as well as good aquaculture candidate (Nwani *et al*., 2013; Odo *et al*., 2017).

II. MATERIALS AND METHODS

➢ *Test Chemical and Experimental Area*

Commercial paraquat dichloride 276 g/l (trade name: paracot) manufactured by Hubei Xianlong Chemical Industry Co., Ltd. N0 36 Yanjiang East Road, Xiantao, Hubei, China was chosen for this experiment due to its popularity as a contact herbicides in Nigeria and was procured from a commercial store in Port Harcourt, Rivers State. The experiment was carried out in the Department of Fisheries and Aquatic Environment laboratory, Rivers State University (RSU), Nkpolu-Oroworukwo, Port Harcourt, Rivers State.

➢ *Procurement of Test organism and Acclimation*

One hundred *C. gariepinus* juvenile with weight ranging between 250 to 300g was procured from a commercial farm in Port Harcourt, Rivers State and transported in plastic troughs to the aquaculture center, Department of Fisheries and aquatic environment Rivers State University, Port Harcourt, River State. At the aquaculture center, *C. gariepinus* were acclimated for three weeks in a concrete tank with routine water change. During the acclimation, *C. gariepinus* were fed twice daily with 3mm blue crown commercial feed at 5% body weight. Feeding was discontinued prior to the transference to experimental troughs. *C. gariepinus* was chosen due to its ability to

withstand stress as well as its high commercial value in Nigeria

- *Experimental Design and Physico-chemical Characteristic of the Water*

Thirty six *C. gariepinus* sub-adults, (wet weight, 362.64 ± 95.88g; total length, 37.65 ± 2.85 cm; means ± STD) were randomly allocated to nine experimental glass aquaria (i.e., 4 fish/tank; 12 fish/ treatment) containing 30L of borehole water. All tanks for the experiment were soaked with 2% nitric acid, double rinsed and dried prior to use. The static-renewal system with 100% water change daily. The experiment was done exactly as those reported in Amachree and Emmanuel (2022). Briefly, after after 96 hour range finding test Paraquat concentration of 552mg/l was selected and used as the concentration for both the intermittent and continuous exposure treatments, there was no added paraquat in the control group. The fish in the intermittent exposure were exposed to paraquat for two days and recovered for another two days in clean borehole water while, the fish in the continuous exposure were exposed to paraquat daily for 14 days. One fish/tank (i.e., 3 fish/treatment) were randomly selected on day 7 and 14 for organosomatic index. For day 0 (initial stock, before exposing the treatment groups to paraquat) control group, three fish were collected and kept in a separate glass tank for one day to adjust to experimental condition. Thereafter, fish were collected, measured (total length, cm and weight, g) killed and organs excised for organosomatic indices. *C. gariepinus* were fed twice daily at 5% body weight throughout the experimental period. Physico-chemical characteristic {temperature (°C), pH and dissolved oxygen, (DO mg/l)} of the water was monitored daily throughout the experiment.

- *Organ Collection for Organosomatic Index*

Organs (gill, liver and Kidney) were collected on days 0, 7 and 14 from individual fish (i.e., one fish/ tank; 3 fish/treatment) for organosomatic indices. Before excising the organs, each fish was measured for the total length (cm) and whole body wet weight (g). Thereafter, fish were killed by a blow on the head and organs (gills, liver and kidney) were removed and blotted dry with tissue paper. The weight of each organ was taken with the use of a digital scale (diamond series A04). The organosomatic index of each organ was calculated according to Dević *et al*. (2016) with the formular:

$$\text{Organosomatic index \%} = \frac{\text{Weight of organ (g)}}{\text{Weight of fish (g)}} * 100$$

----------Equation 1

- *Condition factor*

The condition factor was calculated according (Chigeru and Amachree, 2019; Bagenal and Tesch, 1978) with the formula:

$$\text{Condition factor (Fulton's K)} = 100W/TL^3$$ ----------Equation 2

Where: W = Weight (g); TL = Observed Total length (cm)

- *Statistical Analysis of Data*

Statistical analysis was carried out on all data using the Minitab 16. The data was pooled by treatment and presented as mean ± standard deviation (STD) for n=3 fish/treatment unless otherwise stated. The analysis of variance (ANOVA) and Turkey post hoc was used at 95% confidence level to provide specific information on which mean are significantly different from each other.

III. RESULT

A. Physico-Chemical Parameter of Experimental Water

The result of the physico-chemical characteristics of the water is shown on Table 1. The pH results showed no significant difference in treatment ($p>0.05$). However, there were significant time effects. For example, on day 7 all the treatments showed significant time effect compared to day 0. At the end of the experiment, the control and continuous exposure showed a significant time effect compared to day 0.

The result of the temperature (°C) showed no significant treatment effect apart from day 14. On the 14, the intermittent and continuous exposure showed significant increase in temperature compared to the control (Table 1). There were significant ($p<0.05$) time effects for all the treatments compared to day 0 (initial stock).

For the dissolved oxygen, there was no treatment effect on day 0, but there were significant decreases in the intermittent and continuous exposure compared to the control on day 7. At the end of the experiment, only the intermittent group showed a significant decrease compared to the control and continuous exposure. Also, there were significant time effect in the control and continuous exposure but not the intermittent exposure.

Table 1: Water quality during 14 days exposure to paraquat dichloride

Parameters	Treatments	Exposure days		
		0	7	14
pH	Control	5.53 ± 0.42^{a}	$6.77 \pm 0.06^{a\#}$	$6.80 \pm 0.20^{a+}$
	Intermittent	5.17 ± 0.15^{a}	$6.40 \pm 0.26^{a\#}$	6.53 ± 0.47^{a}
	Continuous	5.47 ± 0.29^{a}	$6.50 \pm 0.26^{a\#}$	$6.77 \pm 0.15^{a+}$
Temperature (° C)	Control	27.87 ± 0.15^{a}	$31.47 \pm 0.55^{ab\#}$	$30.93 \pm 0.55^{a+}$
	Intermittent	27.73 ± 0.35^{a}	$31.97 \pm 0.15^{a\#}$	$32.77 \pm 1.02^{b+}$
	Continuous	27.93 ± 0.23^{a}	$30.90 \pm 0.20^{b\#}$	$31.13 \pm 0.32^{b+}$
Dissolved oxygen (mg/l)	Control	5.02 ± 0.15^{a}	$6.24 \pm 0.52^{a\#}$	$5.01 \pm 0.33^{a\#}$
	Intermittent	5.20 ± 0.66^{a}	4.35 ± 0.46^{b}	4.26 ± 0.13^{b}
	Continuous	5.85 ± 0.12^{a}	$4.53 \pm 0.05^{b\#}$	$4.78 \pm 0.59^{a+}$

Different letters within the exposure day indicates a significant treatment effect (ANOVA, p<0.05). # indicates a significant time effect within treatment compared to the previous exposure day (ANOVA, p<0.05). + represents a significant time effect compared to day zero (day 0, initial fish stock) (ANOVA, p<0.05).

B. Organosomatic Indices

The results of the organosomatic indices of *C. gariepinus* exposed for 14 days to either control (no added paraquat) or 552mg/l paraquat as paraquat dichloride 276 mg/l in intermittent and continuous exposures are presented in Figure 1. The result of the gills-somatic showed that there was no significant treatment effect (p<0.05) on days 7 and 14. At the end of the experiment, values (mean ± STD) were 2.69 ± 0.29, 4.16 ± 3.24 and 3.10 ± 0.28 for control, intermittent and continuous exposure respectively. However, the intermittent exposure showed a significant time effect on day 7 compared to the day 0 (initial stock).

The result of the Hepatosomatic index showed a transient significant increase in the continuous exposure compared to the intermittent exposure and control on day 7. However, at the end of the experiment (day 14), no significant treatment effect was observed (p>0.05). Values (mean ± STD) were 1.89 ± 0.12, 1.61 ± 1.12 and 1.90 ± 0.70 for control, intermittent and continuous exposure respectively. There was a significant increase in the control group on day 14 when compared to the previous time (day 7).

The result of the Renasomatic index revealed that there was no significant treatment or time effect (p>0.05) in all treatment groups and days during the 14 days exposure. At the end of the experiment values (mean ± STD) were 0.51 ± 0.15, 0.56 ± 0.40 and 0.47 ± 0.10 for control, intermittent and continuous exposure respectively.

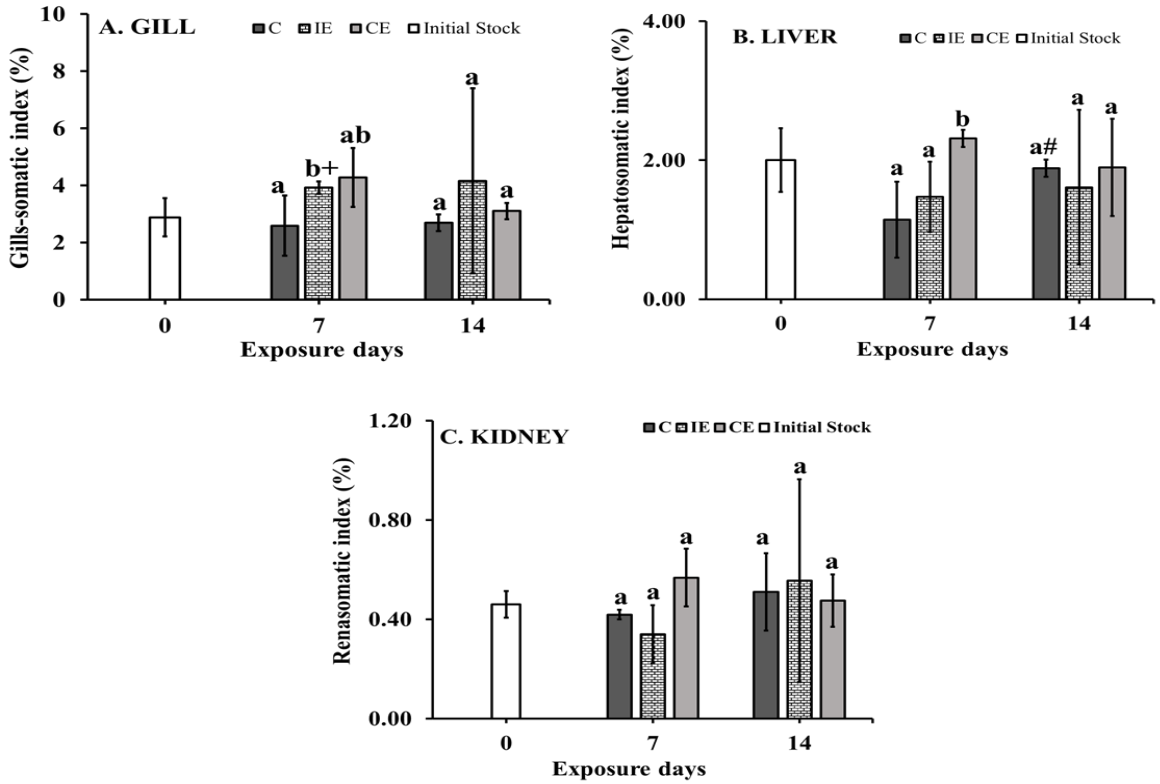

Fig 1: Gill- (A), Hepato- (B) and Rena- (C) somatic indices (%) of *C. gariepinus* sub-adult after 14 days exposure to paraquat. Different letters within the exposure day indicates a significant treatment effect (ANOVA, p<0.05). # indicates a significant time effect within treatment compared to the previous exposure day (ANOVA, p<0.05). + represents a significant time effect compared to day zero (day 0, initial fish stock) (ANOVA, p<0.05).

C. Condition Factor

The result of the condition factor (K) of *C. gariepinus* exposed for 14 days to either control (no added paraquat) or 552mg/l paraquat in intermittent and continuous exposures is shown in Figure 2. There was no significant treatment effect on day 7. However, on day 14 there was a significant decrease in the intermittent and continuous exposure compared to the control difference (p<0.05) with. Also, there were no significant time effect apart from the continuous exposure. The continuous exposure on day 14 showed a significant decrease compared to day 7.

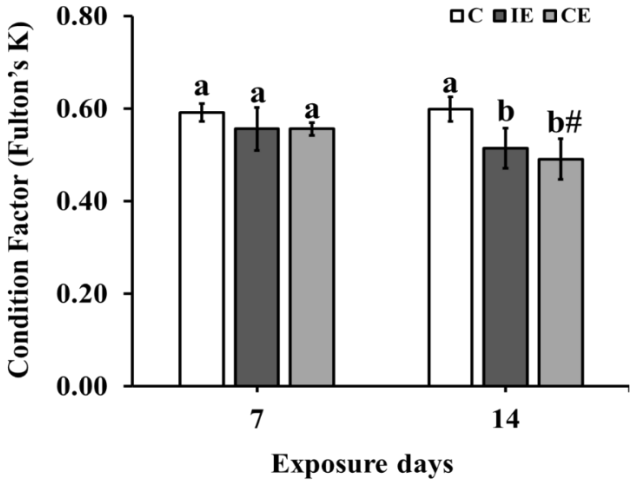

Fig 2. Condition Factor (Fulton's K) of *C. gariepinus* sub-adult during 14 days exposure to paraquat. Different letters within the exposure day indicates a significant treatment effect (ANOVA, p<0.05). # indicates a significant time effect within treatment compared to the previous exposure day (ANOVA, p<0.05). + represents a significant time effect compared to day zero (day 0, initial fish stock) (ANOVA, p<0.05).

IV. DISCUSSION

A. Physico-chemical characteristics of experimental water

Physico-chemical characteristics plays an important role as they affect growth, health and reproduction of aquatic lives (Adamu and Kori-Siakpere, 2011). Contaminants such as herbicides can change water quality and may cause many problems to fish, such as diseases and structural alterations (Chang *et al.*, 1998). However, this has not been the case in the present study, as the range for pH (5.17-6.80), temperature (27.73-32.77 °C) and DO (4.26-6.24 mg/l) were within the tolerant range for the species (Epbah and Amachree, 2019; FEPA 1991; Adeniyi *et al*., 1989).

B. Organosomatic Indices

Organosomatic indices which describes the ratio of organs to body weight and can be linked to some environmental changes (Ronald and Bruce, 1990) as well as effect of chemicals on target organ (Giullo and Hinton, 2008). At the end of the experiment, there were no significant treatment effect in all treatments including the control for GSI, HSI and RSI. This implies that commercial paraquat did not cause any changes in the weight of the gill, liver or kidney in relation to the body weight.

The gill is one of the major site of uptake of toxicant from the aqueous phase. The gill epithelium serves a variety of vital physiological function, it is the major site of gas exchange, ionic regulation, acid-base balance and nitrogenous waste excretion by fishes (Evans, 1987). Moreso, pesticides has been reported to cause both physiological and morphological damages to the gills especially in areas of osmoregulation (Evans, 1987). The results of the present study did not show any differences in gills-somatic index among the treatments including the control, indicating the gills were not affected by the paraquat exposure. However, Kazlauskiené *et al.*, (2010) reported increased gill weight when *Oncorhynchus mykiss* were exposed to 0.4mg/l nickel resulting in gill epithelial cell necrosis and increase in secondary lamella.

The liver is an energy reservoir and serves as an organ of detoxification. In the presence of environmental stressor (s) these function might be altered causing changes in the weight of the organ (Dekić *et al*., 2016; Gabriel, *et al*., 2009). For bony fish, HSI ranges from 1 to 2 % (Oguri, 1978). In the present study, on day 7 there as a transient significant increase (2.31 ± 0.12) in HSI in the continuous compared to the intermittent or control, however it was lost at the end of the experiment. This might be an initial response by the organ to paraquat. According to Jenkins (2004), increased HSI might be due to enzymatic decontamination activities which frequently occurred in fish exposed to pesticides. The result of HSI in the present study were similar to those reported by Uedeme-Naa and Deekae (2016) in their work on *C. gariepinus* exposed to chronic levels of linear alkyl benzene sulphonate but higher when compared to those reported by Wilfred-Ekprikpo (2021) with dimethoate on *Heterobranchus longifilis;* and Edori *et al.* (2013) after exposure of paraquat on *C. gariepinus.*

Renasomatic index was not statistically significant during the 14 days exposure regime, indicating that paraquat did not affect the weight of the kidney. The results are similar to those reported earlier (Inyang *et al.*, 2017; Ogamba *et al*., 2014) with catfish.

C. Condition Factor

Condition factor compares the wellbeing of fish with the hypothesis that heavier fish of a given length are in better physiological condition than the less robust in relation to its welfare (Bagenal and Tesch, 1978). In fishery science, the condition factor (K) is used to compare the overall wellness or fitness of fish (Seher and Suleyman 2012). According to Bagenal and Tesch (1978), a fish is in good condition when k≥0.5). In the present, there was no significant treatment effect on day 7. However, on day 14 there was a significant decrease in the intermittent and continuous exposure compared to the control difference (p<0.05). This result is contrary to those of (Edori *et al*., 2013) who reported values of k>0.5 after 21 days of exposure to paraquat. The differences in the values might be as a result of the fish not able to feed properly during the present study.

V. CONCLUSION

In conclusion, exposure of commercial paraquat to *C. gariepinus* did not affect the organosomatic indices but resulted in poor condition factor especially during continuous exposure. It is important to note that in the present study, high concentration (554 mg/l) of paraquat did not cause any changes in organosomatic indices. However, some other studies have reported increased values of various organosomatic indices at low levels of 0.8mg/l paraquat (Edori *et al*., 2013). This reason for this is unclear but might be the source of the paraquat.

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