

Chronic Toxicity of Paraquat on Liver and Gill Electrolyte in The Catfish *Clarias Gariepinus*

Edori, O S¹; Edori, E S². And Okpara, K. E.³

1. Department of Chemistry, Ignatius Ajuru University of Education, PMB 5047 Rumuolumeni, Port Harcourt, Nigeria

2. Government Comprehensive Secondary School Mbiama, Ahoada West, Rivers State Nigeria

3. School Medical Laboratory Science, Rivers State College of Health Science and Technology, PMB 5049 Rumueme, Port Harcourt, Nigeria

Abstract: The chronic effect of paraquat on the catfish *Clarias gariepinus* was assessed by comparing the changes in electrolytes in the organs (gills and liver) of a control group (0.00mg/L) and toxicant exposed groups (2.00mg/L, 4.00mg/L, 6.00mg/L and 8.00mg/L). The levels of the electrolytes were determined on 20 fishes of 220.50 ± 15.33 g mean weight and 30.43 ± 1.22 mean total length. The value of the chloride ions in the gills and the liver were significantly ($P > 0.05$) lower than the control value except at 8.00mg/L. The value of sodium ion in the gills showed increase in levels and was significant ($P > 0.05$) at 6.00mg/L but the case was reverse in the liver where decrease in levels was observed in all the treatment groups. Significant ($P > 0.05$) higher values were observed in potassium levels in the treated groups in the gills when compared to the control values, while in the liver, no significant ($P > 0.05$) changes were observed. The result of this study shows that paraquat can cause marked changes in electrolytes levels of the fish and therefore can be used as a biomarker of aquatic pollution and toxicity.

Keywords: Paraquat, Electrolytes, *Clarias gariepinus*, Gills and Liver

I. Introduction

Countries with high temperatures and high humidity are always associated with weed and insect growth problems. In order to solve these attendant problems, the use of herbicides / insecticides are employed for their control to obtain maximum crop yield (Yuan *et al.*, 2004). Pesticides are also used in aquaculture practices to control a great variety of pest and ectoparasites in fish (Das and Mukherjee, 2000; Kori-Siakpereet *et al.*, 2007). These agrochemicals whether applied directly on water to kill water weed or on farmlands have negative consequences on aquatic biota. Fish and other aquatic animals are very sensitive to aquatic pollution and shows both pathological and physiological alterations when exposed to these xenobiotics (Gabriel *et al.*, 2010; Cecik and Engin 2005).

Though these pesticides may be applied in very low concentrations, yet these sublethal concentrations at the long run will prove to become dangerous (lethal) to organism (Yuan *et al.*, 2004) by altering the behaviour, feeding habit, reproduction rates, school groups (Murty, 1986) and in severe cases may lead to death (Gabriel and Edori, 2010). The aquatic ecosystem is faced with the threat of shrinking genetic base and biodiversity resulting from indiscriminate use of pesticides (Benson and De-Giulio, 1992). Pesticides available in the aquatic environment get accumulated in the body tissues of aquatic species which eventually become integrated into the food chain (Omitoyin *et al.*, 2006). As a result of residual effects, organs such as liver, kidney, gills, brain, muscles and genital organs are destroyed (Ogunsanmi *et al.*, 1994) or hindered from performing their biochemical functions optimally.

Paraquat (N, N- dimethyl- dimethyl-4,4- bipyridinium dichloride) is one of the most used herbicide in the world and it is highly toxic weed killer. It is second only to glyphosate in world wide application (Zeneca, 1996), it was first synthesized in 1882 but its application as a herbicide was not discovered until 1955 in the ICI (now Zeneca) laboratories and its commercial production started from 1961 (Zeneca 1996).

It causes severe, acute and chronic poisoning when it is water borne (Yuan *et al.*, 2004) and readily dissolves and dissociates when in an aqueous media (Amduret *et al.*, 1991). Lungs selectively accumulate paraquat and contains higher concentration than tissue, causing oedema and other lungs damage leading to fibrosis. It also causes liver damage and renal failure as the kidney tries to remove absorbed paraquat (Dial and Dial, 1995).

This study was undertaken to examine the toxic effects of chronic (sublethal) levels of the toxicant (paraquat) on the electrolytes in the liver and gill of an important commercial fish specie *Clarias gariepinus*.

II. Materials And Methods

Clarias gariepinus (220.50 ± 15.33 g mean weight and 30.43 ± 1.22 cm mean total length) were bought from a private farm in Port Harcourt close to the university of Port Harcourt in Rivers State Nigeria. They were

transported to the Chemistry department laboratory of the Ignatius Ajuru University of Education, Port Harcourt. The fishes were acclimated to laboratory conditions in individual tanks for seven days with bore hole water with 10 litre effective volume in a 30 litre plastic aquaria. The mouth of the aquaria were covered with 1mm nylon mesh to prevent escape of fish from the aquaria. The fish were fed with 31- 35% crude protein diet at 2% biomass during the acclimation and the experimental period.

Completely randomized design was used in the experiment with five treatment levels and four replicates. The test solutions were prepared from a stock of 20g/l and was diluted to the desired concentration and a control. Fishes were fed during the experimental period as was in the acclimation. The solution for the assay was renewed daily to maintain the concentrations. At the end of the experimental period (21 days), the fishes were killed by striking a blow on the head and dissected to remove the liver and the gills. 0.5g of the samples (gills and liver) were macerated and mixed with 5ml of deionized water and centrifuged at 3000 rpm for ten minutes. The supernatant was transferred into plain bottles and stored frozen (-2^oC)

The samples were taken to the laboratory for electrolytes analysis. Sodium (Na), potassium (K) and chloride (Cl) ions concentrations were determined using the automatic analyzer and optimal test by means of flame photometry as was described by Schales and Schales, (1941). The concentrations of the various electrolytes were expressed as mmol/L. The data obtained were subjected to analysis of variance (ANOVA) to determine if significant differences existed between the means in the parameters at different levels of contamination. Where differences existed, Duncan's Multiple range test (DMRT) was used to compare the difference between the means.

III. Results

In the gills, chloride ions were lower in all the test concentrations except at the highest concentration which was 126.50 ± 3.00 mmol/L as against the control value of 117.00mmol/L. The lowest level of chloride was observed at 2.00g/L which was 33.00 ± 0.90 mmol/L. However, sodium ions increased in all the concentrations above that of the control (343.50 ± 3.06 mmol/L). The highest recorded value of 500.00 ± 13.44 mmol/L was recorded at 6.00mg/L concentration followed by that of 4.00mg/L (390.00 ± 6.40 mmol/L) and 8.00mg/L (375.00 ± 8.13 mmol/L). There was an observed decreased levels of potassium ions at 6.00mg/L which was 22.27 ± 0.75 mmol/L as against the control value of 24.20 ± 0.97 mmol/L. There were noted increase in all other concentrations which were 30.80 ± 3.31 mmol/L, 31.21 ± 0.19 mmol/L and 38.07 ± 5.55 mmol/L for 2.00mg/L, 4.00mg/L and 8.00mg/L respectively.

In the liver, decrease in levels of the chloride ion was observed in all the test concentrations. The value of 140.00 ± 8.21 mmol/L was observed in the control followed by that of 6.00mg/l which was 136.5 ± 4.37 mmol/L. The lowest value of 48.66 ± 2.80 mmol/L was recorded at 4.00mg/L test concentration. The levels of sodium ions were all slightly lower than that of the control (330.59 ± 4.52). Other values were 320.67 ± 0.35 (4.00mg/L), 311.00 ± 13.49 mmol/L (8.00mg/L) and 302.00 ± 10.72 mol/L. The lowest value of 298.00 ± 5.03 mmol/L was observed at 2.00mg/L. Potassium ions were in the range of 32.73 ± 1.52 mmol/L(2.00mg/L) as the highest to 25.91 ± 0.57 mmol/L (6.00MG/L) the lowest level as against the control value of 29.66 ± 1.30 mmol/L.

IV. Discussion

Electrolytes are ions in solution which acquire the capacity to conduct electricity and their balance in the body of organism is essential for the normal function of cells and organs. According to Harper (1977) and Gabrielet *al.* (2009), the basic function of electrolytes in the body lies in the control of fluid distribution, intracellular and extracellular acido-basic equilibrium which culminates in the proper maintenance of osmotic pressure of body fluids and normal neuro-muscular irritability.

Chloride is the major anion found in the outside of the cell and the blood. It combines with sodium in the body to form sodium chloride (NaCl) and plays the role of helping the body to maintain normal fluid balance (Gabriel *et al.*, 2009). The observed decrease in this ion in the fish organs (gills and liver) may have resulted from a dehydration process in the fish and stomach (intestinal) secretions (Tomassoet *al.*, 1980). However, stomach diseases, over reactivity of the parathyroid glands and certain kidney diseases leads to increase of this ion in organism (Gabriel *et al.*, 2009).

Sodium ion is the major ion (cation) in the extracellular fluid. Sodium plays a critical role in body functions. The brain, nervous system and muscle require the transmission of electrical signals for the organisms communication. The implication of the overproduction and underproduction can lead to cell malfunctioning and also indicates damage to the gills and the kidney (Rajannaet *al.*, 1981). However, a little increase in this ion (Na⁺) is an indication of improvement of kidney function. Decrease in levels of sodium ion (Na⁺) affects the heart functions of the organism and a neurotoxic damage to the central nervous system of the organism under test (Adedeji, 2010).

Potassium ion (K⁺) is the major positive ion in the intracellular fluid and is essential for normal cell function and body regulation. The observed increase and decrease in potassium (K⁺) ion in this study is as a result of the interference of the toxicant with normal organ function of the gill and liver. An increase or decrease in potassium (K⁺) ion normally results in irregular heartbeats (arrhythmias) which can be fatal in extreme conditions (Gabriel *et al.*, 2009).

Sodium and potassium are essential for the activity of many enzymes and are involved in ATP transport which participates in several metabolic processes. Na⁺ and K⁺ATPases are located in the membranes of cells and are responsible in the active transport of Na⁺ and K⁺ across cell membrane (Rajanna *et al.*, 1981).

Generally, the imbalance electrolytes in fish causes lateral line imbalance and hormonal disorder through affective endocrine organs through attack by pesticides (Tella, 2005; Gabriel *et al.*, 2009).

The changes observed in the electrolytes in the fish organs (gills and liver) may have been caused by deleterious effects posed by paraquat toxicity.

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Table 1. Cl⁻, Na⁺ and K⁺ in the gills of *Clarias gariepinus* exposed to paraquat for 21 days.

Concentration of paraquat (mg/L)	Cl ⁻ (mmol/L)	Na ⁺ (mmol/L)	K ⁺ (mmol/L)
0.00	117.00 ± 14.48 ^a	343.50 ± 3.06 ^{ab}	24.20 ± 0.97 ^b
2.00	33.00 ± 0.90 ^d	348.50 ± 10.39 ^{ab}	30.80 ± 3.30 ^{ab}
4.00	93.33 ± 7.49 ^b	390.00 ± 6.40 ^{ab}	31.21 ± 0.19 ^{ab}
6.00	63.00 ± 3.82 ^c	500.00 ± 13.44 ^a	22.27 ± 0.75 ^b
8.00	126.00 ± 3.00 ^a	375.00 ± 8.13 ^{ab}	38.07 ± 0.55 ^a

Means with the same superscript in the same column are not significantly Different (P>0.05)

Table 2. Cl^- , Na^+ and K^+ in the liver of *Clarias gariepinus* exposed to paraquat for 21 days.

Concentration of paraquat(mg/L)	Cl^- (mmol/L)	Na^+ (mmol/L)	K^+ (mmol/L)
0.00	140.00±8.21 ^a	330.50±4.52 ^a	29.66±1.30 ^a
2.00	63.50±3.00 ^c	298.00±5.03 ^a	32.73±1.52 ^a
4.00	48.66±2.80 ^c	320.67±10.35 ^a	29.22±0.50 ^a
6.00	136.50±37 ^a	302.50±10.72 ^a	25.91±0.75 ^a
8.00	106.50±7.66 ^b	311.00±13.49 ^a	28.98±1.95 ^a

Means with the same superscript in the same column are not significantly differently ($P > 0.05$)

Table 3: Percentage of control of Cl^- , Na^+ and K^+ in the gills of *Clarias gariepinus* exposed to paraquat for 21 days.

Concentration of paraquat(mg/L)	Cl^-	Na^+	K^+
0.00	100	100	100
2.00	28.21(-71.79)	101.46(1.46)	127.27(27.27)
4.00	79.77(-20.23)	113.56(13.56)	128.97(28.97)
6.00	53.85(-46.15)	145.56(45.56)	92.02(-7.98)
8.00	107.69(7.69)	109.17(9.17)	157.31(57.31)

Negative sign in the table shows the level of decrease while positive sign shows the level of increase as against the control.

Table 4: Percentage of control of Cl^- , Na^+ and K^+ in the liver of *Clarias gariepinus* exposed to paraquat for 21 days.

Concentration of paraquat(mg/L)	Cl^-	Na^+	K^+
0.00	100	100	100
2.00	45.36(-54.64)	90.17(-9.83)	110.35(10.35)
4.00	34.76(-65.24)	97.03(-2.97)	98.52(-1.48)
6.00	97.50(-2.50)	91.52(-8.47)	87.36(-12.64)
8.00	76.07(-23.93)	94.10(-5.9)	97.71(-2.29)

Negative sign in the table shows the level of decrease while positive sign shows the level of increase as against the control.