Changes in Electrolytes Levels in the Plasma of African catfish (*Clarias gariepinus*) Treated with Paraquat Dichloride

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ABSTRACT : Changes in some electrolytes such as Sodium (Na^+), Potassium (K^+), Chloride (Cl^-) and Calcium (Ca^{2+}) in the plasma of juveniles and adults sizes of Clarias* gariepinus *exposed to paraquat dichloride at different concentrations of 0.00mg/l –control, 2.50mg/l, 5.00mg/l and 7.50mg/l. The electrolytes levels in the fish were assessed to determine the levels of osmotic impairment by the chemical. A total forty- eight blood samples were collected from juveniles and adults of catfish exposed to this chemical for a period of 10 days. Blood samples were analyzed using standard laboratory methods. Results from the electrolytes analysis indicated that the values of Na^+ and K^+ ions significantly increased ($P < 0.05$) when compared to the control values. However, there was no significant difference ($P > 0.05$) in Cl^- , while significant reduction ($P < 0.05$) of Ca^{2+} were observed in juvenile and adult fish exposed to the chemical. These alterations were more noticeable in the fish exposed to 2.00 and 3.00 mg/l concentrations of the chemical

Keywords: Toxicity, Electrolytes, Chemical, Fish

I.INTRODUCTION

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 [1]. 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. Electrolytes are molecules found throughout the blood tissues and cells of fishes including *Clarias gariepinus*. [2-4]. In fish inhabiting a freshwater, blood ionic concentrations are maintained at much higher levels than those of the ambient water. Hence, they constantly face osmotic inflow of water and diffusion losses of ions across the body surface and gill epithelium [5]. A disturbed hydromineral balance of the body fluids of fish is one of the most conspicuous phenomena observed during stress as there exists an intimate relationship between the surrounding water and the body fluids in teleost fish [6].

Tropical countries are associated with weed and insect infestation challenges. In order to ameliorate these attendant problems, the use of herbicides and or insecticides are employed for their control to obtain maximum crop yield [7]. Pesticides are also used in aquaculture practices to control a great variety of pest and ectoparasites in fish [8]. 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 [9]. Though these pesticides may be applied in very low concentrations, yet these sublethal concentrations at the long run may become lethal to aquatic organism by altering their physiological composition especially the electrolytes.

In recent times, 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 [10], 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 [10]. It causes severe, acute and chronic poisoning when it is water borne and readily dissolves and dissociates when in an aqueous media [10].

This study was undertaken to examine the toxic effects of chronic (sublethal) levels of the toxicant (paraquat) on the electrolytes in the plasma of a popular commercial fish species *Clarias gariepinus*.

II. EXPERIMENTAL WORK

Experimental Location and Fish

The experiment was performed at African Regional Aquaculture Centre, (ARAC), Aluu, Rivers State, Nigeria. The experiment was carried out in the toxicology laboratory unit of the centre. One hundred and twenty (120) juveniles and adult of *Clarias gariepinus* were procured from the center. They were transferred immediately in open, 50L tanks, half filled with water to the laboratory where they were acclimated to laboratory conditions for a period of seven days.

Preparation of test solutions and exposure of fish

The pesticide, paraquat dichloride (dragon), used were purchased from a commercial outlet, in Port Harcourt, Nigeria. Four concentrations 0.00 mg/l (control) , 1.00 mg/L, 2.00 mg/L, and 3.00 mg/L, were prepared following the methods of Gabriel et al. (12). They were dispensed into 30L tanks containing dechlorinated water. Ten fishes were randomly distributed into each test tank. The fish were exposed to the chemical for a period of 10 days.

Determination of Water Quality Parameters

The values of water quality in experimental tanks during exposure were determined with the standard laboratory method described by APHA [11].

Collection of blood samples

Blood samples were collected at the end of 10 day experimental period. Each blood collection was completed within 5 minutes of fish removal from the culture system. 5ml samples were drawn once and poured into Eppendorf tubes containing 500U of sodium heparin used as an anticoagulant. The blood samples were put in ice chest box and transported within 6 hours of collection to biochemistry laboratory for analysis.

Determination of blood serum electrolytes

At the end of each experimental period, 1-2 ml of fresh blood sample was collected by making a caudal puncture with the help of fine needle, in non heparinized sample bottles, and allowing it to clot. Serum was separated by centrifugation at 10,000 rpm for 5-8 minutes in TG20-WS Tabletop High Speed Laboratory Centrifuge. Serum electrolytes such as Na+, K+, Ca2+, Mg2+ and ABGs such as pO2, pCO2 were determined by using Hitachi 902 automatic analyzer (Japan), following the method described by Gabriel et al. (2009). All the tests were performed in triplicates.

Statistical analysis

All the data were expressed as mean and standard deviation of mean. The statistical package, SPSS VERSION 22 was used for the data analysis. The means were separated using two way ANOVA and the two means were considered significant at 5% ($P<0.05$).

III.RESULTS AND DISCUSSION

The water quality parameters in the experimental tanks during the trial are shown in Table 1. The dissolved oxygen (DO) reduced significantly with the increasing concentrations of the chemical, while the values of ammonia increased. However, the pH and temperature were within the same range. The electrolytes levels in the plasma of *C. gariepinus* juveniles exposed to paraquat are shown in Table 2. The values of Na^+ and K^+ ions significantly increase ($P < 0.05$) with increasing concentrations of the chemical. However, there was no significant difference ($P > 0.05$) in Cl^- between the control and other concentrations of exposure. While significant reduction ($P < 0.05$) was recorded in $Ca2^+$ when compared to the control (Table 2). The electrolytes level in plasma of *C. gariepinus* adults treated with different concentrations of paraquat is shown in Table 3. The values of Na^+ and K^+ ions in adult fish increased significantly, when compared to the control value. However, chloride and calcium ions were within the same range with no significant difference ($P > 0.05$).

Electrolytes are molecules found throughout the blood tissues and cells of fishes including *Clarias gariepinus.* [12]. These molecules which are either positive or negative ions conduct electric current and help to balance pH and acid base levels in the fish. Electrolytes also facilitate the passage of fluid between and within cells through a process known as osmosis and also play a part in regulating the functioning of neuro-muscular, endocrine and excretory system of fishes. Electrolyte concentration is indicative of the ability of the fish to osmoregulate. This ability is often compromise with stress[13]. Since the electrolyte are responsible for proper functioning of all type of tissue, the presence of alkali metal series (Na+, K+, Ca2+) are essential for the activation of any enzyme.

Critical loss of body electrolyte reduces the osmotic concentration and leads to circulatory collapse [14].

Table 1: Water Quality Parameters in Experimental Tanks during the Trial (Mean±SD)

Concentrations (mg/l)	Water Quality Parameters			
	DO (mg/l)	pH	Temperature (^{o}C)	Ammonia (mg/l)
0.00	5.44±0.05^{c}	6.93±0.40^{a}	28.95±0.01^{a}	0.03±0.05^{a}
1.00	4.39±0.88^{b}	6.79±2.65^{b}	28.22±0.17^{a}	0.31±0.47^{b}
2.00	3.29±0.63^{a}	6.61±2.61^{b}	28.25±0.04^{a}	0.49±0.49^{b}
3.00	2.78±0.34^{a}	6.52±2.45^{b}	28.20±0.44^{a}	0.72±0.83^{c}

Means within the same column with different superscripts are significantly different (P <0.05)

Table 2: Electrolytes in Plasma of *C. gariepinus* Juveniles Exposed to Paraquat Dichloride (Mean±SD)

Concentrations (mg/l)	Electrolytes (mmol/L)			
	Sodium (Na^{+})	Potassium (K^{+})	Chloride (Cl^{-})	Calcium (Ca^{2+})
0.00	157.33±21.09^{a}	6.83±0.30^{a}	0.89±0.01^{a}	1.89±0.12^{c}
1.00	215.39±21.68^{b}	9.09±2.14^{a}	0.63±0.16^{a}	1.45±0.77^{b}
2.00	241.07±22.62^{b}	11.41±2.77^{b}	0.45±0.02^{a}	1.14±0.04^{b}
3.00	259.02±12.14^{c}	13.40±2.09^{b}	0.21±0.04^{a}	0.77±0.01^{a}

Means within the same column with different superscripts are significantly different (P <0.05)

Table 3: Electrolytes in Plasma of *C. gariepinus* Juveniles Exposed to Paraquat Dichloride (Mean±SD)

Concentrations (mg/l)Farms	Electrolytes (mmol/L)			
	Sodium (Na^{+})	Potassium (K^{+})	Chloride (Cl^{-})	Calcium (Ca^{2+})
0.00	212.18±26.82^{a}	5.91±0.29^{a}	0.97±0.26^{a}	1.99±0.12^{b}
2.50	244.45±17.08^{b}	10.95±2.74^{b}	0.24±0.15^{a}	1.21±0.33^{b}
5.00	268.84±15.33^{b}	8.03±3.03^{b}	0.23±0.41^{a}	1.89±0.29^{b}
7.50	288.65±28.88^{b}	17.24±3.98^{c}	0.20±0.00^{a}	0.82±0.13^{a}

Means within the Same Column with Different Superscripts are significantly Different (P > 0.05).

Changes in Electrolytes in the plasma of juveniles and adult sizes of *Clarias gariepinus* exposed to paraquat for 10 days fluctuated within the experimental group. Fluctuation and stabilization of values of electrolytes was also reported by Gabriel *et al*. [15], when they exposed *Clarias gariepinus* to cypermethrin. This may be due to the toxic nature of the toxicant. In addition to this, Prasad *et al*. [16] noted that stabilization and increase in Na^{+} and K+ ions could be a stress induced response occasioned by the chronic exposure of fish to toxicants which may have activated certain physiological and metabolic mechanisms that could lead to a rapid uptake of the electrolyte from water, food material and a possible reduction of ion efflux. Sodium and Potassium are essential for the activity of many enzymes and also in the transport of ATP which participates in several metabolic processes. Fluctuation of values recorded in this present study is a clear indication of distortion of metabolic in the plasma of the fish [17]. Typically, electrolytes perform a vital role in gaseous exchange and inter-compartmental water balance, therefore elevated or low levels observed in this study may lead to hyper or hypo function of the organs or tissues[18].

CONCLUSION

This research work has revealed that the toxicity of paraquat on some electrolytes in *Clarias gariepinus*. These parameters could serves as useful biomarkers of sublethal effect of paraquat on African catfish. Additionally, the use of paraquat for weeds and insect control close to aquatic environment and ponds should be

restricted

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