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Changes in Metabolites in the Plasma of *Tilapia guineensis* Exposed to Sodium Bromide

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Abstract

To ascertain the extent of metabolic changes in fish exposed to chemical in aquatic environment, metabolic responses in *T. guineensis* exposed to Sodium Bromide at various concentrations of 0.00 controls, 0.50, 1.00, 1.50, 2.00 and 2.50 mg/L were studied. *T. guineensis* of the juvenile and adult sizes totaled 180 were used for the study. The study's findings showed that when compared to control values, the values of metabolites including creatinine, total bilirubin, and total protein were significantly lower ($P< 0.05$) in the exposed fish, whereas urea levels were significantly higher ($P< 0.05$). In contrast, these changes were more obvious in the juvenile fish that had been exposed to the toxin. This work provides baseline data that can be helpful for future comparative studies of metabolic stress in aquatic biota from polluted coastal environments and effective bio- monitoring of the aquatic biota.

Keywords: Metabolites; Sodium Bromide; Aquatic Environment; Fish; Toxicology

Abbreviation: ATP: Adenosine Triphosphate.

Introduction

In aquatic ecosystems that pass through agricultural areas, there is a considerable risk of chemical contamination [1]. One of the main means by which chemicals are moved from an application area to other places in the environment is through water. When an organism enters an aquatic environment, it undergoes a number of modifications, including alterations to its growth rate, nutritional value, behavioral patterns, and so on. Since fish are a crucial link in the food chain and their contamination with pesticides upsets the aquatic system, it is vital to learn the negative effects of contaminants, especially pesticides, on fish [2]. The chemical formulations used in agricultural techniques in Nigeria are thought to have an impact on non-target organisms, which then find their way to freshwater bodies and contaminate them [3].

In recent years, due to its cost-effective method, early warning signal, suitability in the assessment of overall toxicities of complex mixtures, and measurement accuracy, biomarkers for bio-monitoring environmental quality in aquatic ecosystems have gained considerable attention as a promising tool. Industrial effluents and other harmful admixtures are released into our coastal environment, which can modify the aquatic ecosystem's physical, chemical, and biological properties and lead to an ecological imbalance [4]. The released xenobiotic compounds that are bioavailable in the aquatic system have a propensity to attach to particular cellular components known as receptors that are located on the cell surface, inside the cell, either in the cytoplasm or on cell organelles, or both. When a xenobiotic binds to its receptor, the cell may go through processes that are poisonous or have other negative effects. Biochemical markers are the aquatic organism's quantifiable reactions to xenobiotic substances in the water [5].

Biomonitoring is the process of using aquatic organisms to systematically assess changes in water quality. Fish are frequently employed to measure the contamination levels of coastal areas as well as to monitor urban and industrial effluents [6,7]. Due to their high responsiveness and sensitivity to changes in the aquatic environment, which play an increasingly important role in the bio monitoring of environmental contamination, aquatic creatures like fish and mollusks serve as bio indicators of pollution. Biomarkers were thought to be a trustworthy way to assess how the body reacts to environmental risk so that preventative action may be done [8,9]. For evaluating an animal's health state in relation to environmental contamination, blood and metabolic parameters are crucial biomarkers [10].

Changes in blood parameters, particularly in investigations of pollution, represent pathophysiological situations in animals. As a result of exposure to toxicants, changes in the biochemical parameters indicate changes in the metabolic rates of organisms [11]. Because harmful compounds bioaccumulate in fish for a long time, fish are suitable bio indicators of water pollution [12]. Information on the effects of Sodium bromide on metabolites of *T.guineensis* is scanty in literature. Hence this study therefore, assessed metabolic responses in *T.guineemsis* exposed to different concentrations of sodium bromide in the laboratory.

Materials and Methods

Experimental Location and Fish

The study was conducted at the African Regional Aquaculture Center in Buguma, Rivers State, Nigeria, which is a branch office of the Nigerian Institute for Oceanography and Marine Research. During low tide, ponds yielded 180 *T. guineensis*, 90 of which were juvenile and 90 of which were adults. The fish were brought to the lab in six open, 50-liter plastic containers, where they acclimated for seven days.

Preparation of Test Solutions and Exposure of Fish

In this experiment, sodium bromide was acquired from a store in Port Harcourt, Nigeria. *T. guineemsis* were subjected to the substance in triplicates at concentrations of 0.00 control, 0.50, 1.00, 1.50, 2.00, and 2.50 mg/L. Each test tank had five fish, placed there at random. The test was conducted for fifteen days. Every day, fresh water was added to the tanks. The fish were given commercial feed twice daily at 3% body weight.

Determination of Blood Serum Electrolytes

A 2ml sample of fresh blood was taken at the conclusion of each experimental period by puncturing the caudal artery with a tiny needle and pouring the sample into heparinized sample vials. Serum was separated by centrifugation in a TG20-WS Tabletop High Speed Laboratory Centrifuge for 5-8 minutes at 10,000 rpm. Following the guidelines provided by APHA [13], the samples were examined for the metabolites creatinine, total bilirubin, total urea, and total protein. There were three copies of each test run. The methods APHA [13] were also used to determine water quality parameters.

Statistical Analysis

The mean and standard deviation of the mean were used to express all the data. The data analysis was done using SPSS Version 22, a statistical program. Using two-way ANOVA, the means were split, and the two means were deemed significant at 5% ($P < 0.05$).

Results

The parameters of water quality Table 1 were all within the same range, with the exception of DO, where lower values were recorded at larger chemical concentrations. Table 2 shows how sodium bromide affected the metabolites in the plasma of juvenile *T. guineensis*. With rising sodium bromide concentrations, it was seen that creatinine, total protein, and total bilirubin levels dropped. When compared to the control values, urea considerably increased. Additionally, Table 3 shows how sodium bromide affected the metabolites in the plasma of adult *T. guineensis*. With rising sodium bromide concentrations, it was seen that creatinine, total protein, and total bilirubin levels dropped. When compared to the control values, urea considerably increased.

Concentration	DO (mg/l)	Temperature (°C)	pH	NH3 (mg/l)
0	5.97±0.54 ^{b}	29.92±2.90 ^{a}	6.69±1.34 ^{a}	0.02±0.00 ^{a}
0.05	5.77±0.72 ^{b}	29.67±3.11 ^{a}	6.59±1.87 ^{a}	0.02±0.00 ^{b}
0.1	5.09±0.51 ^{b}	29.96±1.68 ^{a}	6.63±1.88 ^{a}	0.02±0.00 ^{a}
0.15	5.01±0.89 ^{b}	29.82±3.11 ^{a}	6.65±0.88 ^{a}	0.02±0.00 ^{a}
0.2	4.77±0.32 ^{a}	29.98±5.01 ^{b}	6.68±0.91 ^{a}	0.03±0.00 ^{a}
0.25	4.30±0.71 ^{a}	29.78±4.02 ^{b}	6.60±0.09 ^{a}	0.03±0.00 ^{a}

Means within the same column with different super scripts are significantly different ($P<0.05$).

Table1: Physico-Chemical Parameters of Water in Experimental Tanks of *T. guineensis* Exposed To Sodium Bromide.

Concentration	Creatinine	Urea	Total Bilurubin	Total Protein
0	89.55±2.66 [c]	2.05±0.88 [a]	10.99±1.05 [c]	23.89±1.02 [c]
0.05	75.44±5.09 [c]	3.77±0.44 [a]	10.12±1.88 [c]	18.88±1.72 [b]
0.1	70.33±5.03 [c]	4.05±1.04 [a]	8.09±1.50 [b]	16.90±1.77 [a]
0.15	62.00±3.60 [b]	5.44±1.45 [a]	7.51±0.88 [b]	15.81±1.81 [a]
0.2	57.00±8.04 [a]	6.12±1.21 [b]	4.77±0.90 [a]	13.67±1.89 [a]
0.25	42.61±2.07 [a]	7.33±0.22 [b]	3.02±0.34 [a]	10.00±1.05 [a]

Means within the same row with different super scripts are significantly different (P<0.05).

Table2: Metabolite Activities in *T. guineensis* Juveniles Exposed to Sodium Bromide.

Concentration	Creatinine	Urea	Total Bilurubin	Total Protein
0	95.66±5.89 [c]	5.06±0.01 [a]	23.09±1.99 [b]	38.99±3.88 [c]
0.05	85.89±6.09 [b]	5.07±0.02 [a]	21.77±1.98 [b]	28.95±5.99 [b]
0.1	76.08±7.03 [a]	6.36±0.77 [b]	15.09±1.87 [a]	25.03±6.03 [b]
0.15	63.77±8.06 [b]	5.67±1.15 [a]	13.09±0.87 [a]	22.09±3.88 [b]
0.2	59.55±9.77 [a]	7.06±2.11 [c]	12.66±0.57 [a]	19.88±1.99 [a]
0.25	45.30±2.76 [a]	11.77±4.03 [c]	10.11±1.99 [a]	16.12±1.87 [b]

Means within the same row with different super scripts are significantly different (P<0.05).

Table 3: Metabolite activities in *T. guineensis* adult exposed to Sodium Bromide.

Discussion

The mean values of the water quality metrics did not change significantly (p>0.05) over the course of the investigation. The measured results were similar to the control values with the exception of a small decrease in dissolved oxygen at sodium bromide concentrations of 0.25 mg/l. This outcome is consistent with the research done by Akinrotimi OA, et al. [14] on the effects of sodium bicarbonate exposure on *Clarias gariepinus*. The values of the water quality measures showed little fluctuation, according to their records. According to reports, the values found in this study fall within warm water fish species' tolerance ranges.

In this investigation, sodium bromide content increased with a decrease in total protein, creatinine, and total bilirubin in the plasma of the exposed fish. While urea significantly increased in comparison to the control values. Similar findings in total protein, total bilirubin, and creatinine were reported by Inyang IR, et al. [15] for *Clarias gariepinus* treated to diazinon. Similar findings were made by Ben-Eledo VN, et al. [16], Babatunde MM, et al. [17], who found that prolonged exposure of fish to most toxicants, including pesticides, interferes with protein metabolism and causes a decrease in total protein levels in fish plasma and serum. The decline in total protein and creatinine levels may be brought on by decreased protein synthesis or increased protein loss through excretion and is also suggestive of a renal issue [18]. The extremely low amounts of total bilirubin found in this study, however, imply that the toxicant may not have had an impact on the liver. A rise in urea indicates that the toxicant may have had an impact on the kidney. The ability of the kidney to eliminate these compounds may also point to a rise in glomerular filtration rate in the exposed fish, according to Kori-Siakpere O, et al. [19]. Additionally, an increase in these metabolite values can indicate that the kidneys are working harder to eliminate these metabolic wastes as a result of the harmful effects of sodium bromide.

The reduced levels of creatinine found in this study relative to the control may also indicate that the muscle utilised creatinine outwardly as a result of the stress that xenobiotic caused [20]. As adenosine triphosphate (ATP) and creatinine are both involved in the contractile process in skeletal muscle, which is mediated by the enzyme creatine kinase Percin F, et al. [21], a decrease in the value of creatinine within the experimental group may simply indicate a decrease in the effect on muscle mass. This may also signal that the toxicant-induced stress may have affected the metabolic pathway in the muscle and other tissues. In this study, urea levels were noticeably higher. These substances are the most prevalent non-protein nitrogen components in the body, and measuring their levels is one of the most frequently requested tests to determine how well the kidneys can eliminate metabolic wastes [22]. The exposed fish's Urea levels increased noticeably as a result, according to the results. Since an increase in these values is considered a sign of renal failure, it is possible to hypothesize that the stress experienced by fish after chemical exposure is connected to renal impairment. When interpreting the blood (plasma) concentration using the level of urea, a more accurate estimation of renal function can be made [23-25].

Conclusion

In conclusion, the decreased levels of total protein seen in this study are a sign of reduced protein synthesis or protein loss through excretion, both of which point to renal issues. Increased urea is a sign that the kidneys are unable to eliminate extra waste, and a decrease in creatinine level in exposed fish is suggestive of stress the toxin has placed on the fish. Variations in total bilirubin in fish that were exposed to the toxin raise the possibility that the liver was unaffected. Based on the findings of this investigation, total protein, total bilirubin, creatinine, and urea levels in the plasma of the probe organism may be suitable biomarkers of sodium bromide's sublethal influence on aquatic life.

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