

“The study of sub-lethal toxicity effect of heavy metal cadmium on serum minerals profile of fishes *mystus gulio*”

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Abstract

The fish *Mystus gulio* was exposed to sub-lethal concentrations of heavy metal cadmium. In the present study the evaluation of toxic effect of heavy metal cadmium on serum electrolyte profile on fish *Mystus gulio*. The sodium and potassium ion content decreases as the concentration of toxicants increases. The excretion of more loss ions through excretory organs increased because of induced stress.

KEYWORDS: *Mystus gulio*, Cadmium, Serum, electrolytes, Sodium, Potassium, ions, excretory organs.

Introduction

Natural waters have a high potential risk for receiving metals from natural, geochemical and anthropogenic sources such as an urban runoff, domestic garbage dumps and sewage water treatment plants which causes adverse effects on both biotic and abiotic ecosystem. Due to industrialization, transportation, urbanization there is tremendous dumping of various toxic heavy metals including cadmium in aquatic media. The toxic heavy metals are carried via the food chain to the upper trophic levels in aquatic ecosystem and create vital ecological issues. Cadmium is one of a non-essential heavy metal. Even in minute concentrations of cadmium could cause toxicity to aquatic organisms. The mechanism of heavy metal deposition, detoxification and excretion in specially fishes are not possible in short time hence heavy metal tends accumulate in metabolically active tissues and organs Langston R. W. (1989). The accumulation of cadmium in fish depends upon the sex, age, size and feeding status. Pollution of water is responsible for a very large number of mortalities and incapacitation in the world. Polluted state of water resources has lead to steady decline in fisheries. The insecticides which are liberated into the aquatic ecosystem have tremendous effect on fish and thereby a man. The poikilothermic animals have a tremendous effect on the blood even minute fluctuation in environmental conditions.

Fresh water bodies and adjacent environments are ecological systems that are subjected to continuous stress by natural and man induced perturbations. Fishes *Mystus gulio* have been reported to maintain a relatively narrow range for concentrations of ions in their serum. An effect of sub-lethal concentration of cadmium exposure on sodium and potassium level in blood of *Mystus gulio* has been analyze in the present study. There are reports on impairment of osmoregulatory activity in various fish species under toxicant stress. Gopi (1992) observed an increase in Na^+ , K^+ , Ca^{++} and Mg^{++} ions and decrease in Cl^- ions in blood of *Cyprinus carpio* chronically exposed to sub lethal concentration of Fenthion. Other reports on effect of pesticides on osmoregulatory activity of fish include by Bano (1986), Sastry and Dasgupta (1991), Sivaram Prasad *et al.* (1985).

Materials and Methods

Test fish **Mystus gulio** is selected for the study are more common edible fish species that has been used as test fish by number of researchers earlier. In the laboratory conditions both fish species can be easily collected, breed and maintained. **Mystus gulio** are collected and brought from kalwa creek or Thane creek in which are easily available. Both these fish were acclimatized in the laboratory for more than two weeks before actual use of bioassay test. These fish were maintained in the large glass aquaria containing aged tap water. The aged tap water needs to stabilize constituents of water and more important in the elimination of chlorine. The water in tank was about 2 liter/gm wet weight of the body of the test fish. The water was continuously aerated to maintain the dissolved oxygen relatively constant. Fish were feed with live tubifex worms and daphnia available in the market. Strictly avoided malnutrition and over feeding. To avoid any type of contamination and infection dead fishes was immediately removed. After every eight days entire water was replenished to keep metal concentrations constants. The aquaria were well aerated and dissolved oxygen levels were kept around $7.5 \pm 1.03\text{mg}^{-1}$ throughout the experiment. They were kept free from any disturbances and mechanical shocks, injuries and overcrowding was avoided. The fish were exposed to diffused sunlight, the photoperiod being 10-12 hours. For bioassay test the disease free fish which were found to have acclimatized satisfactorily were used. Prior to the experimentation the fish were not fed for 24 hours. During experiment, Healthy fishes of uniform size and weight were selected. Ten fish of approximately same size were used for each concentration as test. Ten fish were also kept in toxicant free water under analogous conditions.

Acclimated fish of almost equal size (4.5 ± 0.5 cm) were exposed to three sub-lethal doses of cadmium for a period of 4 weeks. The tests were carried out on adult fish and the test period is often restricted to 4 weeks. The sub-lethal concentrations selected for cadmium is 0.021ppm, 0.014, 0.007 ppm.

The experimental and control tanks were maintained in duplicate. The fish were washed with tap water and dried using drying paper before collecting the blood samples. Blood sampling was done by incising the caudal peduncle. At the end of 4 weeks, blood was removed from control and exposed fish using hypodermic syringe. Blood was withdrawn by cardiac puncture or incision of tail Wedemeyer, G. A., Yasutake, W. T. (1977). The samples were centrifuged and Na^+ and K^+ content were estimated from clear supernatant. Na^+ and K^+ ion content was done by using a flame photometer as advocated by Hawk et al., (1965). Na^+ and K^+ ion concentration was expressed as meq/liters in blood of both fishes **Mystus gulio**.

Table No.1

Na^+ content in mmol/litre in the blood of fish, **Mystus gulio** during chronic cadmium exposure for a period of 4 weeks.

Days of exposure	Control	Concentrations of Cadmium mg/litre		
Initial		0.001	0.002	0.003
0 Days	67.423	60.525	56.218	52.135
SD		3.451	5.6025	7.644
PV		10.7825	18.1251	25.5742

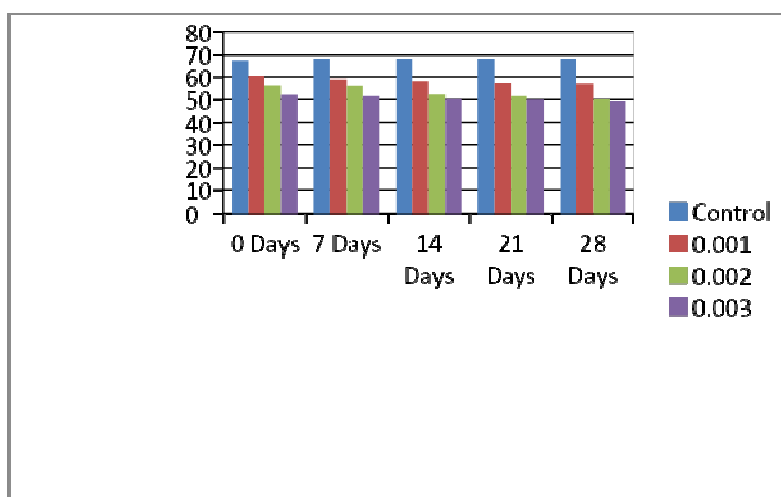
7 Days	68.127	59.029	56.105	51.504
SD		4.549	6.011	8.3115
PV		14.31	19.3541	27.7905
14 Days	68.136	58.103	52.303	50.214
SD		5.0165	7.9165	8.961
PV		15.8952	26.2921	30.2864
21 Days	68.142	57.064	51.503	50.032
SD		5.539	8.3195	9.055
PV		17.6956	27.8139	30.6497
28 Days	68.175	57.002	50.116	49.002
SD		5.5875	9.0295	9.5865
PV		17.8515	30.5332	32.7249

SD=Standard deviation, PV= Percentage variation

Range of SD	Confidence Level
Less than 1	68.3%
Up to 1.645	90%
Up to 1.960	95%
Up to 2.576	99%
Up to 3.291	99.9%
Up to 3.891	99.99%
Up to 4.417	99.999%
Up to 4.892	99.9999%

Graph-1

Na⁺ content in mmol/litre in the blood of fish. **Mystus gulio** during chronic cadmium exposure for a period of 4 weeks



Physico-chemical parameters of water used for toxicological study.

Temperature	27°C
PH	7.3
DO	5.9mg Litre
Free Chlorine	Nil
Total Acidity	3.5mg/Litre
Total Alkalinity	44 mg/Litre
Total Hardness as CaCO ₃	31 mg/Litre
Length of fish	4.2± 0.5cm
Weight of Fish	2.5± 0.5gm

Table :-2

K⁺ content in mmol/litre in the blood of fish, *Mystus gulio* during chronic Cadmium exposure for period of 4 weeks.

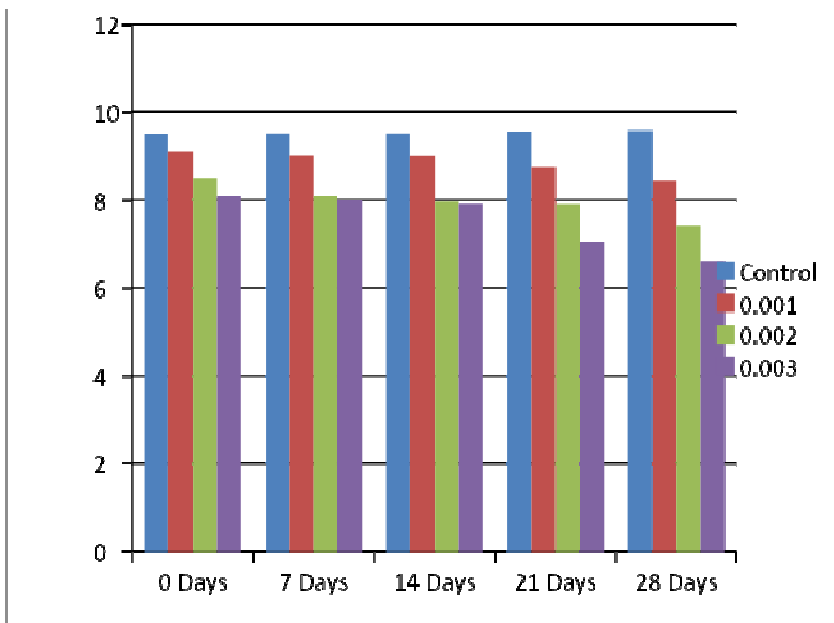
Days of exposure	Control	Concentrations of Cadmium mg/litre		
Initial		0.001	0.002	0.003
0 Days	9.502	9.102	8.503	8.103
SD		0.2	0.4995	0.6995
PV		4.3001	11.0969	15.8932
7 Days	9.505	9.002	8.103	8.007
SD		0.2515	0.701	0.749
PV		5.43578	15.9246	17.1083
14 Days	9.507	8.995	7.962	7.902
SD		0.256	0.7725	0.8025
PV		5.53454	17.6885	18.4613
21 Days	9.562	8.752	7.890	7.052
SD		0.405	0.836	1.255
PV		8.84569	19.1611	30.2155
28 Days	9.575	8.442	7.423	6.600
SD		0.5665	1.076	1.4875
PV		12.577	25.3206	36.7852

SD=Standard deviation, PV=percentage variation

Range of SD	Confidence Level
Less than 1	68.3%
Up to 1.645	90%
Up to 1.960	95%
Up to 2.576	99%
Up to 3.291	99.9%
Up to 3.891	99.99%
Up to 4.417	99.999%
Up to 4.892	99.9999%

Graph:-2

K⁺ content in mmol/litre in the blood of fish, *Mystus gulio* during chronic cadmium exposure for period of 4 weeks.



Physico-chemical parameters of water used for toxicological study.

Temperature	27°C
Temperature	27°C
PH	7.3
DO	5.9mg Litre
Free Chlorine	Nil
Total Acidity	3.5mg/Litre
Total Alkalinity	44 mg/Litre
Total Hardness as CaCO ₃	31 mg/Litre
Length of fish	4.2 ± 0.5cm
Weight of Fish	2.5 ± 0.5gm

Results

The effect of heavy metal cadmium on Na⁺ and K⁺ ion concentration of *Mystus gulio* shown in table 1 and 2 and fig 1 and 2 respectively. Table:- 1 and Table:-2 reveals that exposure to sub-lethal dose of cadmium has resulted in marked depletion of blood (serum) Na⁺ and K⁺ ion content. It can be seen that in case of cadmium, as the concentration of toxic and increases, the level of Na⁺ and K⁺ ion decreases. Similarly, from table no 2, it can be seen that as the concentration of cadmium increases, the level of Na⁺ and K⁺ ion decreases.

Discussion

In blood plasma Sodium is the main cation and is associated with maintenance of acid base balance along with Cl^- and HCO_3^- ions. It also deals with maintenance of osmotic pressure of body fluids, permeability of cells and normal irritability of muscles. In the present study may be attributed to inhibition of ATPase activity the decrease in Na^+ content of blood observed (Nilima Naik, 1991). It may also reveals to possible increase in permeability to Na^+ and K^+ ions as a result of which, these ions might have been lost from blood.

Potassium ions play vital role for maintenance of osmotic pressure, transport of carbon dioxide, muscle and nerve function and acid-base balance. These ions are also essential for protein biosynthesis by ribosomes. Even in case of K^+ ions of blood, inhibition of enzyme ATPase and increased ions or water permeability might have been the possible because of depletion. Inhibition of Na^+ and K^+ dependent ATPase in *Periophthalmus dipus* exposed to Fenvalerate is noted by Sivaram Prasad *et al.*, (1995).

Conclusion

In experimental fish **Mystus gulio** chronically exposed to sub-lethal doses of heavy metal cadmium significant depletion in Na^+ and K^+ ions in blood has been observed. The decrease in ion content of blood may either be due to stress induces loss of ions due to increased excretion through excretory organs.

The regulation of ionic composition of body fluids in animals is presumed to have adaptive significance (Burton, 1973).

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