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STUDIES ON CADMIUM INDUCED SOME BIOCHEMICAL ALTERNATIONS IN AIR BREATHING FISH CLARIAS BATRACHUS (LINN.)

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Abstract

Heavy metals and their salts constitute a very important group of environmental pollutants since they are potent metabolic inhibitors. The inherent toxicity of a metal depends upon its capacity to disturb the dynamic life processes in biological system by combining with cell organelles, macromolecules and metabolites. Cadmium is considered as non-essential element. This study was performed to begin an assessment of effect of the heavy metal on biochemistry of blood serum because blood is a good patho –physiological indicator. Clarias batrachus responded to the cadmium and for duration of 30 days. Clarias shows a decrease in glucose and sodium while increase cholesterol, total protein, urea, creatinine and sodium values. After studying the result of present work it is clear that Cadmium very much affects the energy metabolism, which in long term cause the death of the individual organism and affects the whole community.

Key words: Clarias batrachus, Cadmium, LC50 96h.

Introduction

It is now well realized that environmental problems have increased exponentially in recent decades mainly because of rapid growth in human population and increased demand for several household materials. While on one hand technological development has improved the quality of life, on the other hand it has created a number of health hazards. The toxic chemicals discharged into air, water and soil get into food chain from the environment. By entering into the biological system they disturb the biochemical processes leading to health abnormalities, in some cases to fetal consequences (Gupta, 1998). In 1975 U. S. Environmental Protection Agency (U S E P A), Occupational Safety and Health Administration (O S H A), Consumer Product Safety Commission (C P S C) listed 24 extremely hazardous substances. These include heavy metals also. One such important heavy metal is cadmium (Cd). Cadmium is a well-known cumulative poison in animals that belongs to group II b of the periodic table. Cadmium enters surface water with the discharge of industrial wastes or by leaching of soil, to which sewage sludge is added. It is biologically very reactive and therefore gives rise to both acute and chronic poisoning. Nariagu (1983) emphasized elaborately on effects of cadmium on aquatic organisms. Many reports are available on the effect of Cd on fish blood. Blood is a good bio indicator or a diagnostic tool to study the problem in organ function. The measurement of biochemical changes in blood of fish under exposure to any toxicant may be used to predict effects upon chronic exposure. Present work was a study with a air-breathing catfish Clarias batrachus under sub lethal Cd intoxication. Effects were studied on some serum biochemical parameters.

Materials and Methods

Live and healthy Clarias batrachus were

purchased from local fish market. Fishes were checked for injury and disease, and then washed in .1% KMnO4 solution for 5 minutes. After acclimations of 15 days, 42 fishes of were selected for experiment, irrespective of their sex. The average length and weight of Clarias batrachus was 17+ cm. and 100+ g prior to experiment toxicity tests were conducted to determine the LC50 and safe concentration values of CdCl2 for 96 hours. The physico-chemical analysis of water was done according to Standard Methods published by A.P.H.A. (1992). Both the fishes were divided into 4 equal groups of 6 fishes each. First 3 groups of both the fishes were maintained in sub lethal concentration of CdCl2 separately for 10 days, 20 days and 30 days. Sub lethal concentration of CdCl2 for Clarias batrachus was 2.5 ppm. Fourth groups were served as control for respective groups. All control and treated fishes were fed once daily during the tenure of experiment. Both control and treated fishes were sacrificed at time intervals and blood was collected by serving the caudal peduncle using a sharp knife. Serum was separated from the formed elements through the centrifugation at 3000 rpm. for 15 minutes. Seven biochemical parameters were analyzed in serum, are:

1. Glucose (mg/100 ml) - GOD POD method of Trinder.
2. Cholesterol (mgm/dl) - CHOD PAD method of R. Kettermann.
3. Urea (mg%) - DAM method of D. R. Wybenga.
4. Total Protein (gm%) - Biuret method of T. E. Welchelbaum.
5. Creatinine (mg/dl) - Jaffs method of H. P. Seilig and H. West
6. Sodium (mMol/li) - Flame Photometry method of John D. Baur.
7. Potassium (mMol/li) - Flame Photometry method of John D. Baur.

Results

During the course of experiments no mortality were recorded in both the types of fishes exposed to sub lethal concentration of Cadmium chloride. Certain changes were observed in the coloration, feeding behavior and activeness of the fishes. Both the types of fishes initially became more active but later their activity ceases. The fish's coloration fades a little, fluctuating responses were observed in feeding behavior. Table 1 shows the biochemical indices recorded from exposing Clarias batrachus to 2.5 ppm Cadmium chloride for 10 days, 20 days and 30 days. The following results were obtained-

Table 1:- Some biochemical parameters of *Clarias batrachus* exposed to sublethal (0.4 mg/l) concentration of Cadmium (Chronic studies)

Sr. no	Parameter	Control	10 Days	20 Days	30 Days
01	Glucose (mg/dl)	47.116 ± 1.001	32.256 ±1.0722	27.412 ±1.0722	21.407 ±1.006
02	Cholesterol(mg/dl)	170.33 ±2.32	185.0 ±2.38	192.0 ±1.2909	210.0 ±1.914
03	Total protein (mg/dl)	3.990 ±0.106	4.112 ±0.245	4.170 ±0.054	5.827 ±0.137
04	Urea (mg/dl)	16.017 ±0.211	16.552 ±0.017	17.417 ±0.1067	18.458 ±0.1287
05	Creatanine (mg/dl)	0.256 ±0.0722	0.367 ±0.067	0.458 ±0.0318	0.552 ±0.017
06	Sodium (mg/dl)	134.367 ±1.123	149.000 ±2.768	138.000 ±1.2909	132.167 ±1.674
07	Potassium(mg/dl)	6.083 ±0.343	7.827 ±0.137	8.158 ±0.405	8.552 ±0.017

Mean ± SD of 5 Replicates

Discussion

Heavy metals are widely distributed in free water sources and are harmful to aquatic fauna. Biochemical parameters are the best indicators of stress situations caused by heavy metals. In Clarias batrachus there was a decrease in glucose value. Cadmium like heavy metals have affinity for ligands like phosphate, cystenyle and histidyl side chains of proteins, can bind with carrier protein molecules resulting in inhibition of sugar and amino acid transport (Alvarado, 1966). According to Passov et al,. (1966) metal ions block the active absorption of glucose by the intestinal epithelial cells. Many other workers reported hypoglycemic condition in air breathing fishes due to contaminants (Kurde1990, Sastry 1984). This may be to cope with high-energy demand in stress situations.

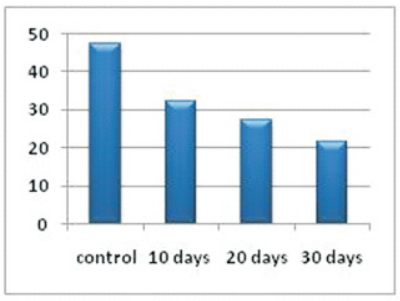

Fig 1. Alternation in Glucose level

Clarias batrachus showed increase in cholesterol value (Figure 2) According to (Kurde, 1990) 60 – 80 % of total serum cholesterol is in esterified form & esterification occurs mainly in liver. Cadmium damages the liver, proportion of esterified cholesterol decreases. Hyper cholestrolemia observed in Clarias it may be due to impairment of liver and inhibition of enzymes, which converts cholesterol into bile acid (Murrey 1990). Reduced lipoprotein lipase activity plays a role in the increment of plasma lipid (Agrawal and Sharma, 1999).

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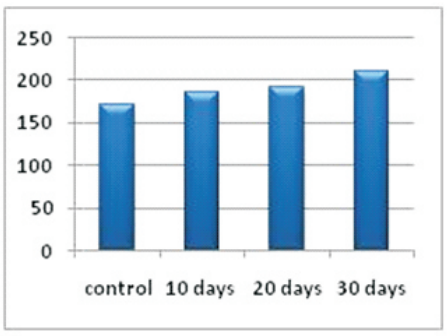

Fig 2. Alternation in Cholesterol level

Proteins play a vital role in physiology of living organisms. All biological activities are regulated by enzymes and hormones, which are also proteins. Assessment of protein content can be considered as a diagnostic tool to determine the physiological phases of the cells. (Kapila 1999) Cadmium competes with Zn for the same sulphahydral group and binds more firmly. Proteins are too sensitive and early indicators of heavy metal poisoning. Kapila (1999) & Kurde (1990) observed elevation in protein content of rat serum due to textile mill effluents. B.Rajanna et al. (1981) reported enhancement in protein content due to cadmium. (Figure 3) The increase in protein content was due to enhancement of microsomal protein synthesis suggested by many workers. Kidney is the target organ of cadmium poisoning.

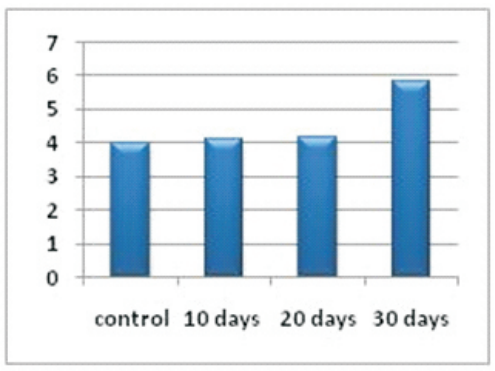

Fig 3. Alternation in Total Protein level

Teleost fishes are primarily amminotelic but their blood contains significant amount of urea and indeed in some teleosts it may account for 20 % or more of the total nitrogen excreted. Occurrence of uremia was reported by many workers (Gupta and Bhargava 1985, Kurde 1990). Renal disorders also elevate serum urea values. The level of urea was influenced by protein content of diet.

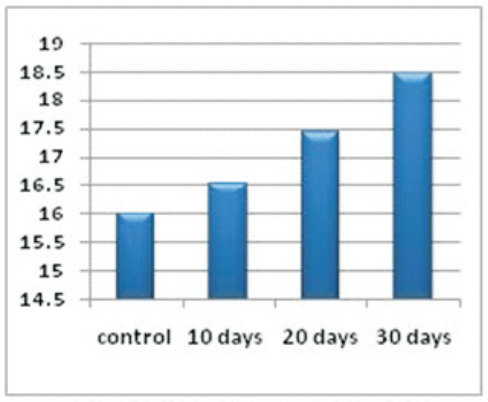

Fig 4. Alternation in urea level

A high protein diet raises the serum urea and low protein diet lowers it. (Figure 4) Creatinine is another nitrogenous waste product that is eliminated by the kidneys, when excretion is suppressed in renal insufficiency. The value is unaffected by protein intake. According to Lall et.al. (1997) rise in creatinine value is an indication of renal tubular damage due to cadmium-induced naphrotoxicity (Kazuo et al. 1980) Figure 5. Shows the regular increase in serum creatinine value in Clarias it proves that Cadmium is more nephrotoxic to non-air breathing fishes.

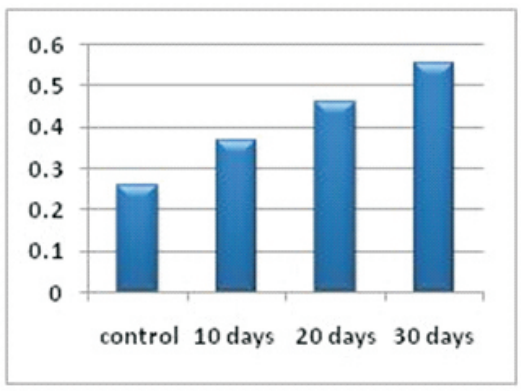

Fig 5. Alternation in Creatinine level

Minerals are mainly responsible for the maintenance of osmotic pressure in blood and proper function of all types of tissues. (Mohanty & Mishra 1983). The presences of activator ions of alkali metal series (Na+, K+) are essential for activity of many enzymes. Toxic metals can alter the concentration of electrolytes in blood. ATP and its related systems have been documented well to participate in several metabolic processes. Na+ - K+ ATPase, located in the cell membrane, has been implicated in the active transport of Na+ and K+ across the cell membrane (B.Rajanna et al., 1981); changes in the levels of plasma ions in present study were due to gill damage and inhibition of enzyme activity.

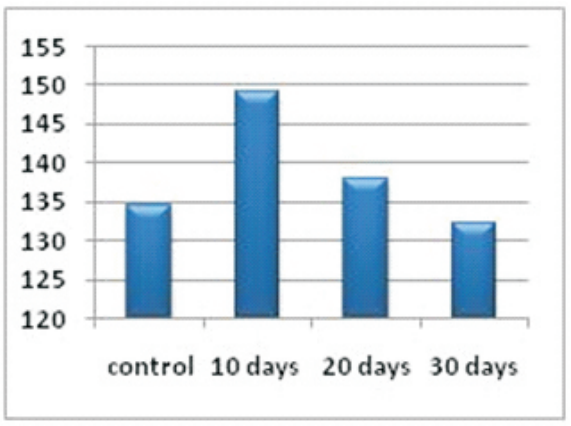

Fig 6. Alternation in Sodium level

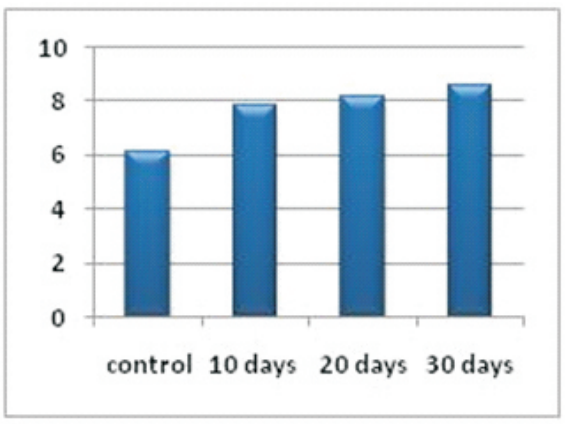

Fig 7. Alternation in Potassium level

Woodling (1999) suggested that plasma ion decrease or increase is due to kidney damage and altered enzyme activity and it has been an indicator of impending death. Changes in the values of sodium in fishes were may be due to the structural difference in gills and tolerance to toxicant. Through reviewing the available literature it may be due to lateral line imbalance and hormonal disorder by affected endocrine organs through heavy metals.

Conclusion

After the above discussion it had been concluded that heavy metals causes deleterious effects on fishes and very much altars the biochemical characteristic of blood. In sub lethal concentration it may not be fetal for an individual organism but it does affect the growth rate and reproduction resulting in disturbance to whole community and tropic levels of food chains, ultimately the ecosystem.

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