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Toxic effect of sodium arsenate on Clarias batrachus

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Abstract

Fishes are excellent bio-indicator of heavy metal pollution .Arsenic is heavy metal which effect on behavior of Clarias batrachus. The present study is carried out to evaluate the toxic effect of heavy metal Arsenic on fresh water teleost Clarias batrachus. Behavarioural changes are observed for chronic toxicity test. The two test concentrations 1/10th and 1/16th ppm to the Lc50 at 96 hours as sub lethal concentration which are 1.31ppm and 0.74ppm for sodium arsenate and sub-acute concentration of sodium arsenate for 7, 15,30,45 and 60 days.

Keywords: Toxic effect, Sodium arsenate, Clarias batrachus.

Introduction

In aquatic ecosystem water being universal solvent, get easily polluted, serving as reservoir for several potent pollutant. The heavy metals impregnated in water get accumulated leading in to the degradation of aquatic ecosystem, thus fish being an important member of the aquatic ecosystem is threatened for damage of mass mortality. Pollutants from cities and industrial effluents drastically alter the water quality of receiving wet lands and inflict damage to the aquatic organism affecting major physiological and biochemical mechanism. Several workers in the field have reported the effect of various aquatic pollutants physiological and biochemical functioning of fishes[1,2].

Suitability of water "the big boon of nature" for life is decreasing intensively due to unscientific waste disposal and indiscreet anthropogenic activities exceeding the water quality index limits thus affecting life preciously.

Pollution from urbanization and injudicious planning with due regard to sustainable development industrial effluent have induced numerous changes in environment, thus environment protection has become the highest cause of concern in the world today due to heavy metal toxicity. Heavy metals form the major heterogeneous group of toxic pollutants among the different pollutant as these metals hamper the harmony of the ecosystem.

Kargin observed that the aquatic organism are easily absorbs dissolved from of heavy metals[3]. Because of accumulated characteristics in food chain, the level of heavy metals in tissue and organs of various fishes living in different aquatic environment have been investigated by many researchers[4].

The accumulation of heavy metals in the tissue of organisms can result in chronic illness and potential damage to the population.

Material and methods

The test fish Clarias batrachus of almost same size were caught in healthy condition from local fish pond of Chhindwara (Madhya Pradesh), the fishes were screened for any physical damage, disease and mortality. The live specimen of the Clarias batrachus having body weight of 40-45 gram were acclimatized under natural photoperiod and standard laboratory condition for 15 days in fiber glass aquaria containing non chlorinated tap water of 50 liter volume to recover from stress . Fishes fed every day twice with wheat flour pellets, boiled eggs protein and ground dried shrimps purchased from local fish market.

For chronic toxicity test the two test concentrations 1/10th and 1/16th ppm to the Lc_{50} value at 96 hrs as sub lethal concentration which are 1.31 ppm , 0.74 ppm for sodium arsenate.

Observation: The behavioral responses were recorded both in control and treated fishes by the exposing the fish Clarias batrachus to sub-acute concentration of sodium arsenate for 7, 15, 30, 45and 60 days. Exposed fishes showed the abnormal behavior during exposure, exposed fishes showed fast feeding habit, restlessness, active swimming and increased gulping of air with increased operculum movement but decrease in movement marked after 30 days against controlled group of fishes. The comparison of the percentage reveals that it was greater with the higher concentration of metal then lower concentration. The surface dwelling and jumping activity of fish were also increased in both exposures of two concentrations. The controlled group was compactly found together while treated group was started to disrupt grouping and with increasing concentration and duration in both the sub lethal groups is toxicant.

The contrast bottom dwelling activity in decreased in all the exposure and it was greater at higher concentration after 30 days. The shaped movement increased as compare to the control fish in both concentrations. Some fishes frequently dash against the wall of container to leap the toxicant medium. This jerky movement and erratic swimming, loss of equilibrium was more marked with increased concentration and duration, indicating the effect of nervous system due to the heavy metals stress, Arsenic caused death of cell at several regions of fins, dorsal and ventral side of body which caused wound on the tail side. In sodium arsenate exposure up to 15days resulted in increase of operculum movement but decreased was marked after 30 days. Fishes showed increase in the bottom dwelling in jumping activity by shaped movements. The exposed fishes found to hanging vertically down in water column. Duration of hanging increased at higher concentration showing fish as in dilemma while controlled fishes were found in rest in bottom of aquaria. With increased duration exposed fishes showed the sign of tiredness and gradually lost the positive rheotaxis and equilibrium. When dead specimen was examined, change in color in gills lamellae was observed. The cyclid was found bulged within change in the color of eyes when compared with the controlled group. The blood clots on gill lamellae were observed. Before their actual death their belly was turn upward and ultimately sank in bottom with lots of mucus layer. No mortality was seen in controlled group fished.

Results and discussion

Most heavy metals and their salts are simple inorganic compounds, the toxicity of which is caused by anions cations or physiochemical properties of the salts. Some salts of heavy metals for e.g. copper, arsenic and trivalent chromium are precipitated in a weakly alkaline medium and thereby enlarge the silt deposits of the water body. Arsenic is the most toxic compound for fish. Toxic effect is observed at concentration 0.74ppm and 1.31 ppm of Arsenate.

Table-1: Effect of Sodium arsenate on behavioral parameter of Clarias batrachus on 7th day.

Parameter number/ min	Control	As 0.74 ppm	As 1.31ppm
Operculum movement	71 0.19	72±0.13	78±0.38
S-shaped movement	3±0.12	4±0.17	5±0.32
Bottom dwelling activity	20±0.12	18±0.77	14±0.06
Jumping activity	2±0.19	3±0.22	5±0.50
Surfacing activity	4±0.8	7±0.23	11±0.32
Jerky movement	2±0.12	3±0.26	4±0.18
Equilibrium status	Normal	Slight loss	Maximum loss

Table-2: Effect of Sodium arsenate on behavioral parameter of Charias batrachus on 15th.

Parameter number/ min	Control	As 0.74 ppm	As 1.31ppm
Operculum movement	70±0.08	82±0.23	88±0.38
S-shaped movement	2±0.12	3±0.99	4±0.22
Bottom dwelling activity	21±0.12	17±.21	13±0.06
Jumping activity	3±0.19	3±0.81	4±0.12
Surfacing activity	3±0.8	8±0.23	10±0.32
Jerky movement	Absent	3±0.26	4±0.18
Equilibrium status	Normal	Slight Loss	Maximum Loss

Table-3: Effect of Sodium arsenate on behavioral parameter of Clarias batrachus on 30th day.

Parameter number/ min	Control	As 0.74 ppm	As 1.31ppm
Operculum movement	69±19	70±0.14	75±0.38
S-shaped movement	2±0.12	3±0.17	4±0.16
Bottom dwelling activity	19±0.12	16±0.77	13±0.17
Jumping activity	2±0.82	2±0.22	3±0.50
Surfacing activity	3±0.9	5±0.23	10±0.32
Jerky movement	1±0.98	2±0.13	3±4.18
Equilibrium status	Normal	Slight Loss	Maximum Loss

Table-4: Effect of Sodium arsenate on behavioral parameter of Clarias batrachus on 60th day.

Parameter number/ min	Control	As 0.74 ppm	As 1.31ppm
Operculum movement	68±0.18	71±0.23	72±0.38
S-shaped movement	1±0.96	2±0.16	3±0.12
Bottom dwelling activity	20±0.11	16±0.13	12±0.02
Jumping activity	2±0.29	2±0.77	3±0.19
Surfacing activity	2±0.7	7±0.55	8±0.39
Jerky movement	1±0.27	2±0.26	4±0.18
Equilibrium status	Normal	Slight Loss	Maximum Loss

Behavioral changes in sodium arsenate exposure: Fish showed change in behavioral pattern during sodium arsenate exposure, like wide range of rapid swimming and erratic movement were notice. The movement was found more erratic at high concentration but at low concentration operculum movement way quite less in fish. Surface activity and jumping activity was high in the arsenic exposure fish.

Eisler is believed that behavioral changes are more sensitive measure of neurotoxicity[5,6]. Orosatti and Cologan suggested that changes in behavior of fish could used as sensitive- indicator of chronic sub lethal toxicant exposure[7].

The behavioral changes in present study are proved to be the good index of toxicity of metal ions of arsenic. The changes like increase operculum movement, erratic swimming and increased surface activity, loss of equilibrium and increased mucous secretion were similar to the observation of Kumar and Gopal, Tripathi et al. observed in Channa punctatus exposed to distillery effluent and fluoride toxicants, Sandal et al. in H. fossils exposed to mercuric chloride and Yadav et al. channa striatus on exposure to fertilizers and industrial waste water[8-11].

The excessive mucous secretion over the gill may inhibit the O_2 diffusion causing respiratory distress[12]. The increased operculum movement and increases surface activity after exposure to both toxicants is suggested to meet the increased demand of oxygen and thus energy due to altered physiological changes and which lead the fish in altered behavioral pattern. Mandal and Kulshreshtha advocated the loss of physical stamina of gills to toxicant summation exposure to Charias batrachus, which may result in increased surface activities, which is similar to changes concerning in present study[13]. The probable cause may be due to hypoxic conditions.

Fish Charias batrachus frequently try to visit water surface for more oxygenation in comprarision to control group fish. Loss of balance, in arsenic treated fish Charias batrachus in present study is a good index of toxic responses of metal and it is likely that the region in the brain associated with the maintenance of equilibrium should have been affected by this toxicant as also discussed by Devi 2003 in fish Oreocharomis mossanbicus[14].

The responses of the fish to the increasing concentration of sodium arsenate during acute toxicity test with regard to oxygen demand was altered in metal. The increased oxygen demand is possible due to compensation of increased energy demand since heavy metals in general above optimum level cause to induce increased metabolic activity to accommodate the chemical stress. The increase in operculum movement enhanced oxygen consumption at higher dose of arsenic it is 1.31ppm/l in Clarias batrachus. During present investigation results in chemical stress and adverse effect of metal ions which invariable increased the respiratory activity of the fish. Similar observations were also registered in Miystusgulio exposed to sodium arsenate[15,16]. The altered respiratory rate may be attributed to reduction in gill permeability leading into low level of oxygen diffusion in gill permeability leading into low level oxygen diffusion so that the fish compensate by increasing the ventilation volume or increased operculum activities. The gill operculum movement was increased initially to support enhanced physiological activities in stressful habitat arid, later decreased possible due to mucus accumulation on gills[17]. Increased mucus secretion in exposed fish Clarias batrachus in present study was possible because of defense mechanisms to protect the body against toxic effect of arsenic.

Conclusion

In this study the effect of arsenic was carried out in Clarias batrachus reflected that the study can be useful biomarker in the environmental bio - monitoring of arsenic contamination. It was found that bio accumulation of heavy metal in fish from a polluted environment resulting in impairment of natural population quality and thus consumption of fishes from such polluted environment should be avoided, also when such fishes are consume as food, arsenic to the deposition of heavy metal in the soft tissue resulting in the lethal effects on human body.

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