International Journal of Current Science Research
www.drbgrpublications.in

IP Indexing - Impact factor – 3.5
Volume: 3; Issue: 6; June-2017; pp 1266-1276. ISSN: 2454-5422

Effect of Trivalent and Hexavalent chromium toxicity on biochemical composition of fresh water Teleost *Labeo rohita* (Ham.)

Venkatachalam. T[1], Natarajan.A.V[2] and Parvathi. K[2]

[1]Department of Zoology, Gobi Arts and Science College, Gobichettipalayam, Tamil Nadu, India.
[2]Department of Zoology, Erode Arts and Science College, Erode, Tamil Nadu, India.
*Corresponding author email: tvenkat1974@gmail.com

Abstract

The aim of the present study was to find out the effect of trivalent chromium and hexavalent chromium on biochemical composition of fresh water fish *Labeo rohita* (Ham.). The 96 hour LC50 value was determined and one tenth and one fifth of the 96 hour LC50 concentrations of trivalent and hexavalent chromium were chosen as sub lethal concentrations for different exposure periods. The present study result shows an appreciable depletion of glycogen, total protein and total lipid in liver and muscle of the fish under chromium stress and hexavalent chromium was more toxic.

Keywords: Trivalent and hexavalent chromium, *Labeo rohita*, glycogen, total protein, total lipid.

Introduction

The indiscriminate introduction of waste with heavy metal into the water resources may pose serious threat to the survival of aquatic fauna including fish populations (Parvathi *et al.,* 2011). In aqueous solution Cr (VI) predominantly exists as chromate ion, which easily penetrates biological membranes and causes cellular damage by inducing oxidative stress (Irwin *et al*., 1997; Begum *et al*., 2006). Chromium (Cr) is a metallic element belonging to the first transitional series of the periodic table. Chromium compounds are reported to be toxic and carcinogenic (Forstner and Witt-man, 1979; Venko., 1985; Parvathi *et al.,*2011). The main sources of chromium compounds in the atmosphere comes from the production of ferrochrome, plants which produce cement, brake lining and catalytic converters of automobiles and tanneries (Fishbein, 1981). Fish are often at the top of the aquatic food chain and may concentrate large amount of some metals such as chromium (Mansour and Sidky, 2002). This metal accumulates in fish organs and humans can be at great risk sometimes even lethal, through biomagnifications of the food chain (Gomaa *et al.,* 1995; Abbas, 1998; Abbas and Mahmoud, 2003, 2004). In the present study, an attempt was made to investigate the acute toxic effects of trivalent and hexavalent chromium on some selected biochemical parameters like glycogen, total protein and total lipid in muscle and liver of *Labeo rohita(Ham.)*.

Materials and Methods

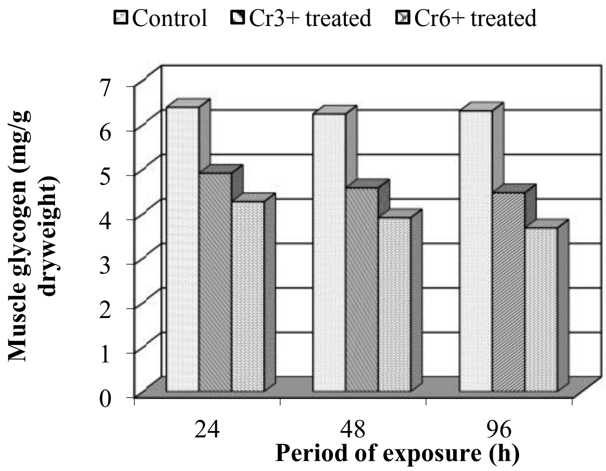
Active specimens of *Labeo rohita* (8.2 - 9.6 cm in length and 9.7 - 12.8 gm in weight) of both sexes were procured from Sirago Fish Farm, Nerinjipet, Eode District, Tamil Nadu. The animals were maintained in large glass aquaria at 25±1º C under diurnal lighting conditions 12L: 12D photoperiod and acclimatized to the laboratory conditions for 28 days. During the period of acclimatization, the fish were fed with commercial fish feed *ad libitum.* The 96 hour LC50 value was determined following Finney's probit analysis (Finney, 1952). One tenth and one fifth of the 96 hour LC50 concentrations were chosen as sublethal concentrations for studies at 24h, 48h and 96h exposure to the trivalent (as chromium (III) oxide) and hexavalent chromium (as Potassium dichromate). Thirty fish in two batches of fifteen each were exposed separately to one fifth and one tenth of the 96h LC50 concentration Cr^{3+} (57.074mgL^{-1}) and Cr^{6+} (36.222mgL^{-1}) which were determined earlier following the method of Finney's Probit analysis. Five fish were sacrificed at the end of 24h, 48h and 96h, blotted dry and weighed. They were later dissected to isolate the whole liver and muscle tissues. The tissues from both treated and control fish were dried for 24h in a hot air oven at 50ºC and the dried tissues were weighed to the nearest mg. The biochemical parameter such as glycogen, total protein and total lipid in muscle and liver tissues were analyzed adopting the standard methods of Kemp Andienne and Hejningen, 1954; Lowry *et al.,* 1951 and Pondey *et al.,* 1963 respectively and the values are given as Mean ± SE of 5 individual observations.

Results and Discussions

Biochemical compositions in fish and other aquatic organisms under heavy metal stress may serve as important bio indicators in the monitoring of aquatic environment (Abbas and Mahmoud, 2004; Shalaby *et al.,* 2005; Abbas *et al.,* 2007). The harmful effects of metals may be due its bio-concentration and their binding with biological constituents of the body

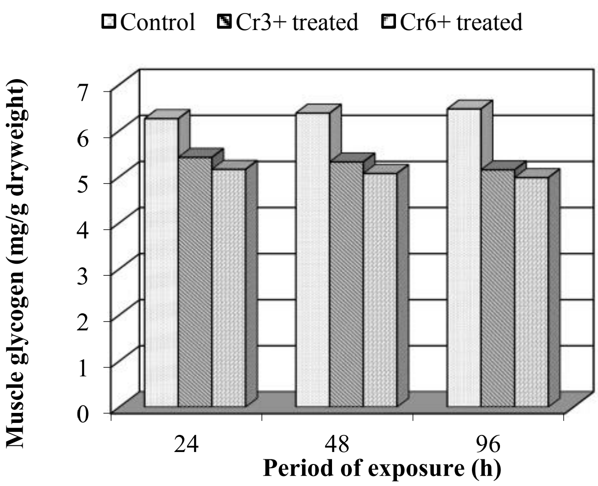
(Passow *et al.,* 1961). In the present study, muscle glycogen was found to be declined as 33.17%, 37.33% and 41.67% over the control at 24h, 48h and 96h of exposure in fish exposed to one fifth of the 96h LC50 concentration of Cr^{6+} while it was found to be 23.16%, 26.60 and 29.16% in fish exposed to Cr^{3+}. (Fig. 1).

Fig.1. Muscle glycogen at different periods of exposure to one fifth of 96h LC50 concentration of Cr3+ and Cr6+ in a freshwater teleost *Labeo rohita* (Ham.)



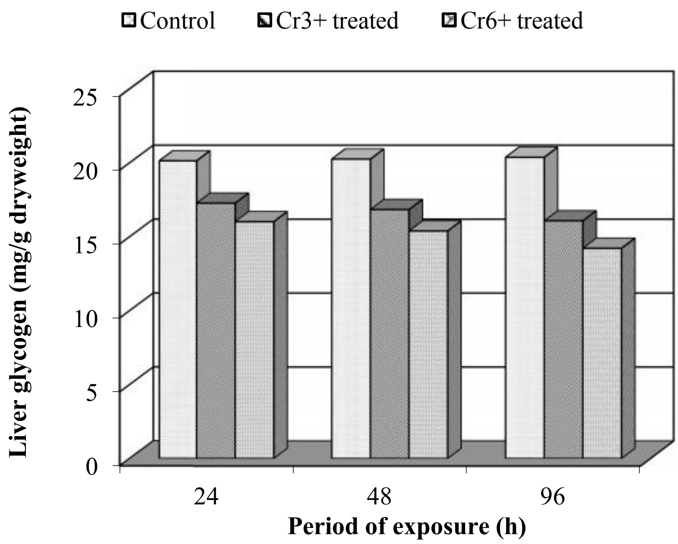
The same trend was observed in fish exposed to one tenth of the 96h LC50 concentration of Cr^{3+} and Cr^{6+} (Figure 2) and it was observed that the muscle glycogen depletion is dose dependant.

Fig.2. Muscle glycogen at different periods of exposure to one tenth **of 96h LC50 concentration of Cr3+ and Cr6+ in a freshwater teleost *Labeo rohita* (Ham.)**



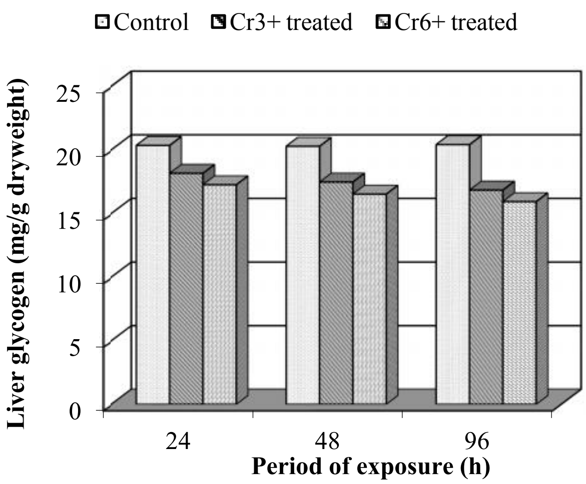
Liver glycogen level was found to be declined in fish exposed to one fifth of the 96h LC50 concentration of Cr^{3+} as 14.21%, 16.84% and 21.07% and fish exposed to Cr^{6+} registered depletion of liver glycogen as 20.42%, 24.01% and 30.20% following exposure at 24, 48 and 96h (Figure 3).

Fig.3. Liver glycogen at different periods of exposure to one fifth of 96h LC50 concentration of Cr3+ and Cr6+ in a freshwater teleost *Labeo rohita* (Ham.)



Fish exposed to one tenth of the 96h LC50 concentration of Cr^{3+} recorded liver glycogen level as 10.76%, 13.85% and 17.49% while those exposed to Cr^{6+} registered depletion of liver glycogen as 15.18%, 18.54% and 21.95% following exposure at 24, 48 and 96h (Figure 4).

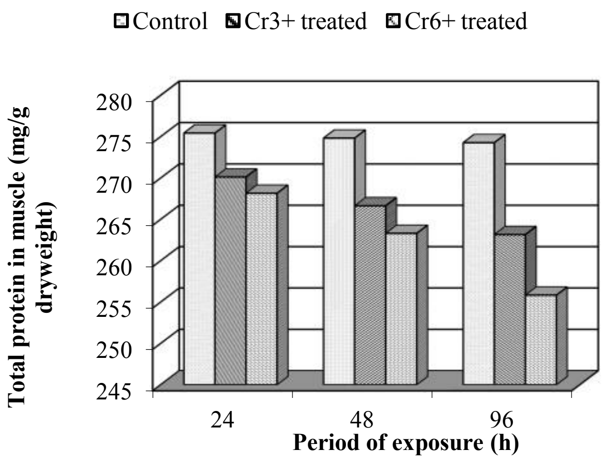
Fig.4. Liver glycogen at different periods of exposure to one tenth of 96h LC50 concentration of Cr3+ and Cr6+ in a freshwater teleost *Labeo rohita* (Ham.)



The depletion of glycogen concentration of the tissues as well as liver of *Labeo rohita* following exposure to one fifth and one tenth of the 96h LC50 concentration may be due to its utilization of the compound as energy source to meet energy demands under trivalent and hexavalent chromium stress. While the more pronounced depletion of glycogen observed in respect of Cr^{6+} exposed fish in both the concentration suggest concentration dependant functional toxicity. It may also be due to the prevalence of hypoxic or anoxic conditions, which normally improves a utilization of energy giving compounds.

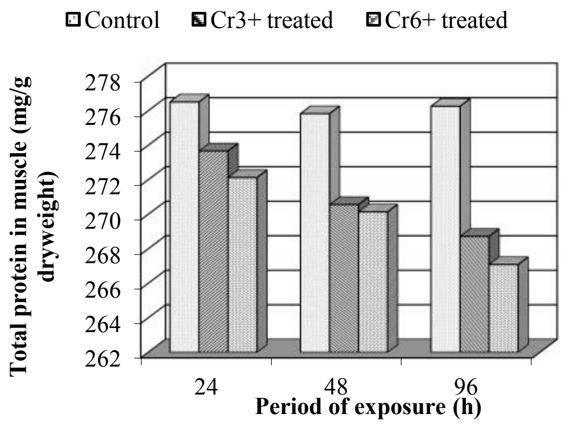
Depletion of total protein in muscle tissue was recorded both in fish treated with one fifth and one tenth concentration of 96hLC50 of Cr^{3+} and Cr^{6+}. The depletion of total protein was recorded as 2.63%, 4.18% and 6.71% as in Cr^{6+} treated fish while the depletion was found to be as 1.92%, 2.97 and 4.05% in Cr^{3+} treated fish, at 24h, 48h and 96h of exposure respectively (Figure 5).

Fig.5. Total protein in muscle at different periods of exposure to one fifth **of 96h LC50 concentration of Cr3+ and Cr6+ in a freshwater teleost *Labeo rohita* (Ham.)**



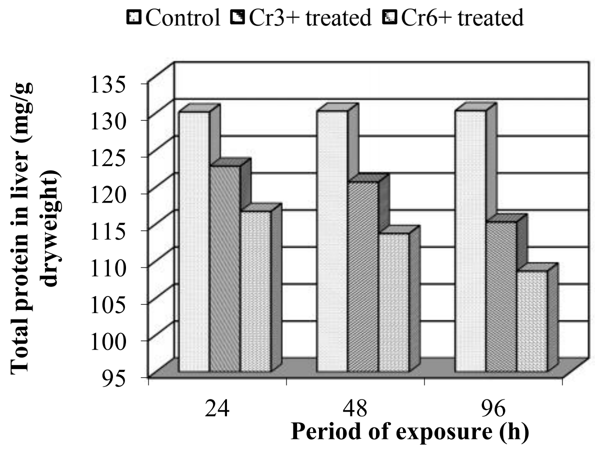
Fish exposed to one tenth of the 96h LC50 concentration of both Cr^{3+} and Cr^{6+} elicited similar depletion pattern. The depletion in Cr^{3+} treated fish was found to be 1.02%, 1.91% and 2.72% at 24h, 48h and 96h of exposure whereas in Cr^{6+} it was recorded as 1.58%, 2.06% and 3.31%, respectively over the control. The depletion was more pronounced in Cr^{6+} treated fish than the Cr^{3+} treated fish (Figure 6).

Fig.6. Total protein in muscle at different periods of exposure to one tenth **of 96h LC50 concentration of Cr3+ and Cr6+ in a freshwater teleost *Labeo rohita* (Ham.)**



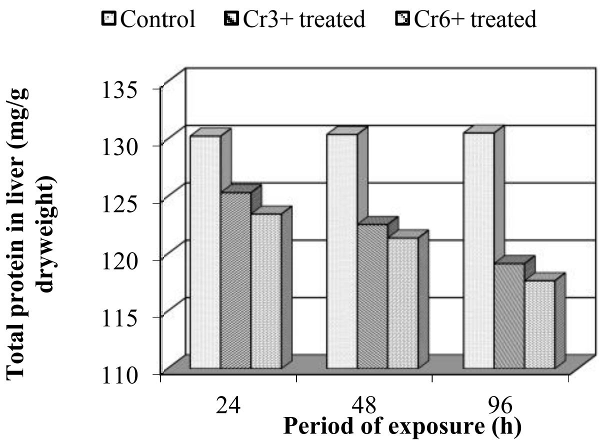
Fish exposed to one fifth of the 96h LC50 concentration of both Cr^{3+} and Cr^{6+} elicited similar depletion of total protein in liver was recorded (Figure 7).The depletion in Cr^{3+} treated fish was found to be 5.62%, 7.36% and 11.53% at 24h, 48h and 96h of exposure whereas it was recorded as 10.31%, 12.69% and 16.62% in Cr^{6+} exposed fish over the control. The depletion was more pronounced in Cr^{6+} treated fish.

Fig.7. Total protein in liver at different periods of exposure to one fifth **of 96h LC50 concentration of Cr3+ and Cr6+ in a freshwater teleost *Labeo rohita* (Ham.)**



More pronounced depletion of total protein in liver was observed in Cr^{6+} exposed fish (5.20%, 6.91% and 9.85%) over the Cr^{3+} exposed experimental fish (3.77%, 6.01% and 8.71%) (Figure 8).

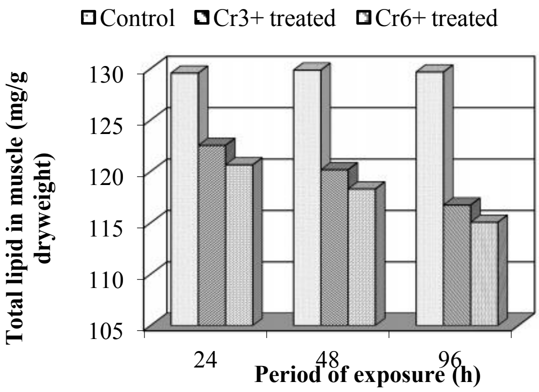
Fig.8. Total protein in liver at different periods of exposure to one tenth **of 96h LC50 concentration of Cr3+ and Cr6+ in a freshwater teleost *Labeo rohita*** (Ham.)



The depletion of total protein in chromium exposed fish may be due to impaired protein synthesis or utilization of more proteins and lipids to meet excess energy demand under trivalent and hexavalent chromium stress (Nagai and Ikeda, 1971). Similar depletion of plasma protein was observed in *Cyprinus carpio* (L.) exposed to chromium VI (Parvathi *et al*., 2011). The depletion was found to be more pronounced in liver of fish exposed to $Cr^{6+.}$

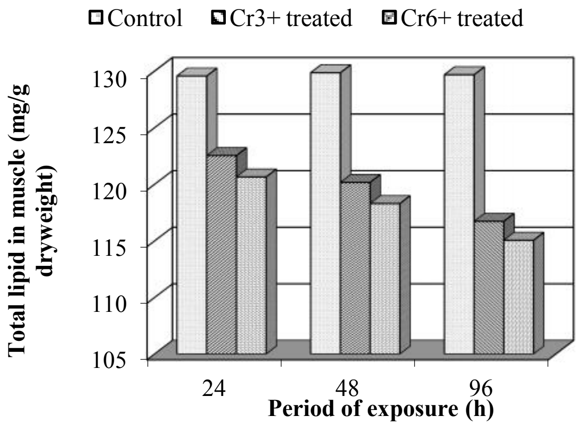
Declined total lipid in muscle of Labeo *rohita* following exposure to one fifth, one tenth of the 96h LC50 concentration of Cr^{3+} and Cr^{6+} was recorded throughout the entire study period. Total lipid depletion in muscle was found to be more in Cr^{6+} treated fish than Cr^{3+} treated fish. When the fish exposed to one fifth concentration Cr^{6+}, the depletion of total lipid was found to be 8.85%, 11.25% and 15.78% whereas the same depletion was found to be 7.22%, 9.36% and 12.26% in Cr^{3+} treated fish, respectively at 24h, 48h, and 96h of exposure (Figure 9).

Fig.9. Total lipid in muscle at different periods of exposure to one fifth **of 96h LC50 concentration of Cr3+ and Cr6+ in a freshwater teleost *Labeo rohita*** (Ham.)



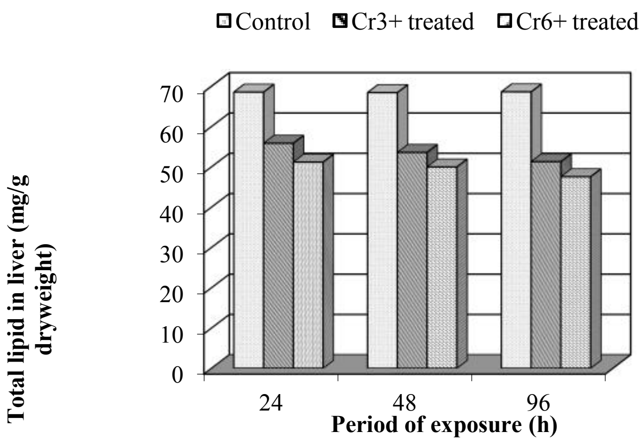
The same depletion in total lipid in muscle was also found to be observed in fish exposed to one tenth of the 96h LC50 concentration of Cr^{3+} and Cr^{6+}. The depletion of total lipid in muscle after exposed to Cr^{6+}. was found to be 6.88%, 8.90% and 11.27% and the depletion was found to be only 5.42%, 7.46% and 9.98%, after exposed to Cr^{3+} at 24h, 48h and 96h. The depletion was found to be more pronounced in Cr^{6+} treated fish (Figure 10).

Fig.10. Total lipid in muscle at different periods of exposure to one tenth **of 96h LC50 concentration of Cr3+ and Cr6+ in a freshwater teleost *Labeo rohita* (Ham.)**



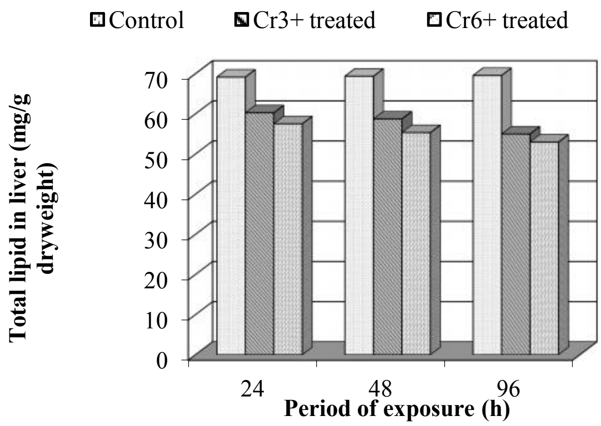
Fish exposed to Cr^{6+} and Cr^{3+} at various period of exposure to one fifth of 96h LC50 depletion of total lipid in liver was recorded as 25.33%, 26.96% and 30.68% and 18.51%, 21.69% and 25.23% at 24h, 48h and 96h of exposure respectively over the control (Figure 11).

Fig.11. Total lipid in liver at different periods of exposure to one fifth **of 96h LC50 concentration of Cr3+ and Cr6+ in a freshwater teleost *Labeo rohita* (Ham.)**



A similar depletion of total lipid in the liver of fish exposed to one tenth of 96h LC50 concentration of Cr^{3+} and Cr^{6+}. The depletion was found to be more profound in Cr^{6+} treated fish as 16.80%, 20.22% and 23.84% than the liver of fish treated with Cr^{3+} was 12.85%, 15.35% and 20.95% at 24h, 48h and 96h of exposure. Cr^{6+} is more effective in exerting toxicity and the depletion was found to be dose dependant (Figure 12).

Fig.12. Total lipid in liver at different periods of exposure to one tenth **of 96h LC50 concentration of Cr3+ and Cr6+ in a freshwater teleost *Labeo rohita* (Ham.)**



The decrease in total lipid and proteins in all the tissues observed in the present study may be partly due to their utilization in cell repair and tissue organization with the formation of lipoproteins, which are important cellular constituents of cell membranes and cell organelles present in cytoplasm (Harper, 1983). The depletion of glycogen, total protein and total lipid was found to be higher in the order of liver > muscle when the fish exposed to Cr3+ and Cr6+ in both one fifth and one tenth concentration of 96h LC50. Cr6+ is more toxic than the Cr3+.

References

Abbas, H.H.H. 1998. Toxicological effects of copper and lead on some physiological aspects in two fish species, blue tilapia, *Oreochromis nitototicus* and African catfish, *Clarias garipinus* Ph.D Thesis. *Faculty of Science,* Cairo University, Egypt.

Abbas, H.H.H. Acute toxicity of ammonia to common carp fingerlings (*Cyprinus carpio*) at different pH levels. *Pak. J. BioI. Sci.* 9 (2006): 2215-2221.

Abbas, H.H.H. and H.M Mahmoud. The toxicological effects of water pollution on the Nile tilapia fish *(Oreochromis niloticus*) collected from four sites along the River Nile *J Egypt Vet Med Assoc.* 63 (2003): 307-323.

Abbas, H.H.H. and H.M. Mahmoud. Hematological and biochemical changes in *Oreochromis aureus* and *Clarias gariepinus* exposed to mixture of copper and lead salts. *Egypt J. Basic. Applied Physiol.* 3 (2004): 89-106.

Abbas, H.H.H., H.M. Mahmoud J.D, Miller. Vitamin C and cadmium toxicity in fish *Oreochromis Niloticus. Online J. Vete. Res*. 11 (2007): 54-74.

Begum *et al.,* G. Begum, J. Venkateswara Rao, K. Srikanth. Oxidative stress and changes in locomotor behavior and gill morphology of *Gambusia affinis* exposed to chromium, *Toxicol Environ Chem* 88 (2006): pp. 355-365.

Finney, D.J. Probit analysis In: Goulden, C.H. 1952. (ed) Methods of Statistical Analysis John wiley. New York.

Fishbein, L. Sources, transport and alterations of metal compounds: an overview. I.Arsenic, beryllium, cadmium, chromium, and nickel. Environ Health Perspect 40 (1981): 43-64.

Forstner, U. and Wittman, G.T.U. Metal Pollution in the Aquatic Environment, *Springer Verlag*, New York. (1979): pp. 486-532.

Gomaa, M.N.E., A.A.K., Abou-Arab, A. Badawy N. Khayria. Distribution pattern of some heavy metals in Egyptian fish organs. *Food Chem*. 53 (1995): 385-389.

Harper, A.H. Review of Bio Chemistry. 20th ed. *Lange Medical Publications Co*, California. (1983): pp 1012.

Irwin et al., R.J. Irwin, M. Van Mouwerik, L. Stevens, M.D. Seese and W. Basham, Chromium VI (hexavalent chromium). 1997. *Environmental contaminants encyclopedia,* National Park Service, Water Resources Division, Fort Collins, Colorado.

Kemp Andienne, J. M. and Kits Van Hejningen. A calorimetric micro method for the determination of glycogen. *J. Biochem.* 56 (1954): 640-648.

Lowry, O.H., Rosebrough, N.J., Lewis Farr, A. Randall, R. Protein measurement with Folin Phenol Reagent. *J. Biol. Chem.*, 193 (1951): 265-275.

Mansour, S.A. and Sidky, M.M. Ecotoxicologcal Studies. 3. Heavy metals contaminating water and fish from Fayoum Governorate, Egypt. *Food Chem*. 78 (2002): 15-22.

Nagai, M. and Ikeda, S. Carbohydrate metabolism in Fish-1. Effects of starvation and dietary composition on the blood glucose level and haepatopancreatic glycogen and lipid contents in *Cyprinus carpio. Bull. Jap. Soc. Scient. Fish.* 37 (1971): 404-409.

Passow, H., A. Rothestein, T.W. Clarkson. The general phrmacology of heavy metals. *Pharmaocol. Rev.* 13 (1961): 183-224

Pondey, S.V., Khan, A.P. and Subramanyam, T.A.V. Micro determination of lipids and serum fatty acids. *Analyst. Biochem*. 6.5 (1963): 120-125.

Parvathi.K, P.Sivakumar C.Sarasu. Effect of chromium on histological alterations of gill, liver and kidney of fresh water teleost *Cyprinus carpio* (L). *Fish.J.Inter*. 6.1 (2011): 1-5.

Kumar Parvathi, Palanivel Sivakumar, Mathan Ramesh, Sarasu. Sublethal effects of chromium on some biochemical profiles of the fresh water teleost, *cyprinus carpio.* IJABPT. 2.1 (2011): 295-300.

Shalaby, A.M., H.R. Abbas, Y.A. Khatab. The effect of sublethal doses of cadmium on the desposition of some trace elements and liver function in common carp (*Cyprinus carpio L.). Egypt J. Basic Applied Physiol.* 4 (2005): 383-395.

Venko, V. Chromium: a review of environmental and occupational toxicology, J. Hyg. *Epidemiol. Microbial. Immunol*. 29 (1985): 37-26.