*Biomedical & Pharmacology Journal*, December 2019. Vol. **12**(4), p. 2049-2053

# Chromium and their Derivatives Causes Physiological and Biochemical Modifications in Diverse Fish Models: A Review

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http://dx.doi.org/10.13005/bpj/1838

(Received: 31 August 2019; accepted: 19 December 2019)

**The current literature surveyreviews the physiological and biochemical impact of chromium and their derivative across various fish species in aquatic ecosystem around the globe. Chromium and its derivatives such as sulphates, oxides, chlorides, nanoparticles etc have been found to have a deleterious effect on neurology, ionoregulatory, physiology, biochemistry, metabolism and histological parameters in fish. Different species of fish like *Labeorohita, Channa punctatus, Danio rerio, Catlacatla, Carassiusauratus* and their reaction to Chromium toxicity has been chiefly discussed in the review. In conclusion centered on studies accomplished by various research groups, we can infer that chromium and their derivatives pose analarming threat not only to fish, but also to ecology and environment.**

**Keywords**: Chromium, Ecology, Environment, Fish, Nanoparticles.

In this day and age, pollution is becoming the major issue around the world. Aquatic ecosystem in particular is more susceptible to heavy metal contamination by extensive industrialization and rapid urbanization. Control and alleviation of the same has become a challenging issue to environmentalists. These lead to adverse effect on water quality of all the water bodies over the world[1]. The aquatic ecosystem receives anthropogenic wastes and become ultimate depository of heavy metals. Heavy metals are identified as metallic element that have a relatively higher density in contrast to water [2].Once the heavy metals enter to living organisms through food chain, it becomes irreversible[3]. The chief sources of heavy metals are agriculture wastes (pesticides, insecticides etc.) industrial waste. Bio-accumulation of these pollutants in aquatic organisms such as fish from different water bodies depends on the intensity of pollution[4]. Nanoparticles also contributeto a significant impact on polluting the environmental health. Metallic nanoparticles are a flexible class of materials [5]. Fish physiology, metabolism, genomics and behavior may reflect the purity of aquatic environment and its resistance to contamination byheavy metals and nanoparticles [6]. Elemental chromium is not habitually found in pure form. But it naturally exists as an ore. It has different oxidation states ranging from $Cr^{2+}$, $Cr^{3+}$, $Cr^{4+}$, $Cr^{5+}$, $Cr^{6+}$. But trivalent $Cr^{3+}$ and hexavalent $Cr^{6+}$ oxidation states are frequently available in environment and are the most stable forms of

chromium [1]. In the present literature survey we shall discuss the effects of chromium and their derivatives including nanoparticles on different types of fish models.

**Review**

***Labeorohita* (Rohu)**

*L. rohita*is a fresh water fish of the carp family. The fish is one of the top edible fish in Asia. The studies conducted revealed that *L. rohita*whenexposed to different concentrations of chromium, the fish body balance were impaired at the dosageof ed 28.99 mg /L concentration. $LC_{50}$ was reported to be30.36mg/L[1]. In another study *L. rohita*were exposed to chromium oxide nanoparticles at 25mg/L concentration. There results obtained demonstrated decline in red blood cell count and total leucocyte count.The studies also revealed pathological changes in different organs of treated fish compared to untreated fish [7]. Exposure of fish to the sublethal concentration of chromium 6 mg /L for 30 days resulted into mild histopathological conditions[8].*L. rohita* were exposed to 10% sub lethal concentration for 96 h $LC_{50}$ of chromium at 3.5 ppm for 10, 20 and 30 days. They observedhistopathological alterations in gills upon 10 days of exposure. And after 30 days of exposure, fusion of gill lamellae, hypertrophy, degeneration of liver cells and liver lesions were recorded [9]. *L. rohita* were treated with organic and inorganic form of chromium separately. Inorganic chromium in the form chromium chloride hexahydrate was treated at the concentration of 0.3, 0.5 and 0.6 mg / kg and organic chromium in the form of chromium picolinate at the concentration of 0.3, 0.5 and 0.6 mg / kgto different groups respectively. To the other group of *L. rohita*, were treated with the chromium. The research group noted an elevated growth of fish with organic chromium of concentration 0.3 mg / kg. Other fish were genetically damaged [10].

***Channa punctatus* (Bloch)**

*C. punctatus* is a fresh water fish. It is the species of spotted snakehead. The report showed that fish were exposed to chromium concentration of 20 mg / L and 40 mg / Lfor the study of behavior changes upon treatment and $LC_{50}$ was found to be 41.75 mg /L. Later the fish were treated with glucose in the concentration range 10mM, 1mM, 0.1mM, 0.01mM, 0.001mM. The rate of glucose absorption was higher when the concentration is 0.001mM in the presence of chromium. The enzymes like lactate dehydrogenase, pyruvate dehydrogenase, succinate dehydrogenase were suppressed upon exposure of chromium in the concentration 2.6 mg /L for 60-120 days[1]. Exposure of hexavalent chromium to *Channa punctatus* for 96 h $LC_{50}$ was found to be 41.75 mg / L. Thisresulted in irregular swimming, damage of gill cells, renal destruction and hepatocytic abnormalities [11].

***Danio rerio* (zebrafish)**

The Zebrafish is the freshwater fish belonging to family Minnow. It is a popular aquarium fish and is native of south Asia. Zebrafish is one of the major model organism.The report showed that the $LC_{50}$ for 96 hours of chromium trivalent and chromium hexavalent was found to be 105.279 mg /L and 26.03 mg /L[12]. Fishes were exposed to different concentrations of chromium and it was determined that the concentration equal to 0.7 mg / lit will effect on swimming speed and turning times [13]. To assess the reproductive ability upon treatment, male and female fishes were exposed for 96 hours $LC_{50}$of chromium concentration with 37.96 mg / lit for three months, and were allowed to breed. There was reduction in fertility to 47%. Moreover, there was a reduction of 45% hatchability. Survival of larvae after seven days of treatment, reduced to 57%. These studies concluded that treatment with chromium can cause reduction in reproduction ability of fishes[14].

***Cirrhinusmrigala***

*C. mrigala* is the fresh water fish. *C. mrigala* is the species of rayfinned fish. The study reports that fishes were provided with 34 mg /L to 40 mg /L concentration of trivalent chromium for 30 days. $LC_{50}$ was found to be 34 mg /L by the Probit method. Theresearch group noticed a gradual decrease in the level of alkaline phosphatase, acyl carrier protein (ACP), amylase and lipase. Moreover, at the concentration of 34 mg /L, theyobserved a decreased lymphocytic infiltrate in muscle and liver[15]. In an another study *C. mrigala* was treated with different concentrations of chromium[6]. The $LC_{50}$ was determined to be 18.20 mg /L. The physico- chemical parameters were maintained at optimum level. For lower sub lethal concentration, the accumulation of chromium in different organs were in the order: kidney > liver> gill H" muscle, and for higher sublethal concentration was reported to be: kidney > muscle

> liver > gill. Accumulation of maximum level of Cr in the kidney were recorded to be97.326 mg/g and 162.637 mg/g. Next to the kidney, the liver accumulates high amount of chromium and was demonstrated to be 87.325 ± 3.683 µg/g. It was evaluated that muscle also accumulates high level of Cr in higher sublethal concentration is 91.227 µg/g [6].

***Carassiusauratus* (Goldfish)**

The Gold fish is a fresh water fish of the family cyprinidae. Gold fish were exposed to the chromium in the concentration range 4ppm, 6ppm, 8ppm and 12ppm for 96 h, which demonstrated multiple morphological and behavioral changes[16]. The accumulation of chromium was in order gills > intestine > skin [16]. Gold fish were acclimitized to laboratory conditions and exposed to aqueous hexavalent chromium of 5% and 10% for 96 h. The $LC_{50}$ was determined to be 85.7 mg/L. The lipid hydroperoxide (LHP) in liver was exposed to 5% and 10% $LC_{50}$ with increase in concentration for 1, 2, 3 and 4 weeks separately. The increase in 1 week wassignificant $p < 0.005$ when compared to the control.However,elevation in week 2, 3 and 4 were not significant $p > 0.05$ from control. DNA damage in Gold fish were assessed by Comet Assay by staining. The gold fish were exposed to 5% and 10% $LC_{50}$dosage and observed for all 4 weeks of exposure to check the percentage of DNA damage in kidney cells. The research group, noted the increase in week 1 and 2 was 5% and 10% respectively and wassignificant $p < 0.05$ from control, whereas elevation in week 3 and 4 were not significant $p > 0.05$ compared to the control[17].

***Cyprinuscarpio L.***

The common carp or European carp is widespread fresh water fish in Europe and Asia. According to a study, fish were exposed to chromium in the concentration range 15 mg/L, 25 mg/L, 35 mg/L and 45 mg/L. $LC_{50}$ for 96 h was found to be 30 mg/L. Upon increasing the chromium concentration, gills pavement cells were desiccated [18]. In another study, *Cyprinuscarpio* were treated to trivalent chromium in the concentration range 7.5, 15, 30 and 60 µg/L for 21 days. Scales were highly damaged in the concentration range of 30 µg/L and 60 µg/L [3]. A study was performed on *C. carpio*whichwere exposed to sublethal concentration of 5ppm for 48 h to examine the bioaccumulation in different organs. High amount of metal was found in liver resulting in liver damageand also metabolism of all organs were disturbed [19].A study reported that Cyprinus*carpio* were exposed to sublethal concentrations of hexavalent chromium in the range 0, 25, 50, 75, 100, 125 and 150 mg/L. They observedthat high concentration of chromium led toprimary hematological changes such as increase in WBC, mean corpuscular volume, erythrocyte sedimentation rate and enzymes such as aspartate aminotransferase, ALT, ALP and ACP, RBC indicating anemia [20].

***Catlacatla***

*Catlacatla* is a fresh water fish. *C. catla* were treated to chromium for 60, 120 and 240 days at constant water temperature 30æ%C, pH 7.5 and total hardness 300 mg/L. $LC_{50}$ for 96 h was recorded to be 77.01 mg/L for 60 days. It was observed that 15.37µg/gof chromium was accumulated in the different organs of the fish. Percentage of accumulation depends on the age of the fish, while chromium accumulation was found to be maximum in fish exposed for 240 days [21]. In a different study catla fish were exposed to both $Cr^{3+}$ and $Cr^{6+}$ for 8, 16 and 32 days to study the histopathology modifications of gills. Lethal and sub- lethal concentrationof *C. catla*wasdetermined by Probit method. Trivalent chromium of $LC_{50}$was found to be 59.68 mg/L and sub lethal concentration of 100 mg/L for 96 h and lethal concentration of hexavalent chromium was shown to be 10 mg/L and sub lethal concentration was 3.5 mg/L [22].

***Oreochromis aureus* (Blue tilapia)**

*Oreochromis aureus* is a fresh water fish of the family Cichlinidae. It is native to Northern and western Africa and Middle East and is an important food source throughout the world. According to a study, *O. aureus* fish were treated with the chromium in the concentration range of 10, 15, 20, 25 and 30 µg/L for 28 days. There were no much behavioral changes in low concentrations of chromium. But upon treating with 20 µg/L, there was a minorchangein the behavior of fish and at the concentration 30 µg/L, the fish were shivering withrespiratory disorder, swimming in capsized position had been observed. Accumulation of chromium in gills was four times greater than the muscle. And the accumulation of chromium in the skin is almost twice as muscle [23].In another study *O.aureus* were treated with chromium in

the concentration range of 10, 15, 20, 25 and 30 mg/L for 28 days. The $LC_{50}$ was found to be 32.35 mg/L. Accumulation of chromium in different organs were in the order: gill > skin > muscle. The concentration range of chromium accumulation in the gill was 3.11-45.23 µg/g and in the muscle was 0.86-12.34 µg/g [24]. To study the effect of dietary chromium complement on humoral antibody response and some blood constituents,*O. aureus* was fed at 1 or 2 mg/kg of fish and immunized with sheep red blood cells simultaneously. There was decreased plasma glucose and increased cholesterol and decreased albumin:globulin ratio[25].

## CONCLUSION

The literature review concludes that the chromium derivatives such as ions, oxides, chlorides, nanoparticles pose a major impact on aquatic biota. Exposure of significant amount of chromium to wide array of fishes will involve a crucial and harmfulimpact are histopathology, DNA damage, behavioral changes such as swimming, cell disruption, metabolism, physiological changes etc. This can be concluded that theunnatural amount of chromium or any other component will impose a great impact on nature.

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