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Examining the toxicity of Cadmium chloride in common Carp (*Cyprinus carpio*) and Goldfish (*Carassius auratus*)

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Abstract

Heavy metals are one of the factors threatening food security and the ecosystem health. The 96h LC_{50} test is a method to find amount of resistance and survival of different species in confronting with different concentrations of pesticides and other risk factors. The aim of the present study was to evaluate the sensitivity of the two species of freshwater fish (common carp (*Cyprinus carpio*) and Goldfish (*Carassius auratus*) than heavy metal cadmium. For this purpose, the fish were in a range of different concentrations of Cadmium (0, 0.2, 1, 2, 6, 10 and 15 ml/L). After compatibility time, 147 fish were selected randomly and were divided into 7 treatments (0, 0.2, 1, 2, 6, 10 and 15 ml/L Cadmium chloride) and 3 repetitions (number of fish in each treatment was 21). Data analysis revealed that common carp was more sensitive to Cadmium toxicity and 96h LC_{50} was lower 8.845 ml/L. The 96h LC_{50} of Cadmium for Gold Fish was 9.202 ml/L. The results showed that cadmium chloride was highly toxic for freshwater fishes; however, its toxicity was different for various species ($p<0.05$).

Keywords: Acute toxicity, Heavy metals, Cadmium chloride, freshwater fishes, LC_{50} 96h.

1 Introduction

Batch of metallic elements such as Fe, Cu, Zn and Mn are essential for the survival of living beings. In addition to these elements, there is another group called heavy metal. The heavy metals are a group of non-essential metals (unimportant) unlike other metals have intense desire, to combine with the organic molecules [1, 2]; for this reason, it is important to study the impact of the heavy metals on ecosystems.

Heavy metals can combined with organic molecules and accumulate in the tissues of organisms. These processes will eventually leading to food contamination and degradation of the food chain [3]; Heavy metals accumulate in the tissue of living organisms and move it along the food chain creates risks in terms of food security; also, exposure of fishes with these metals can be lead to toxic effect, such as tissue damage and death [4]. Previous studies have shown industrial waste, hospital waste and oil extraction process contain varying amounts of heavy metals such as Cu, Hg and Cd [5].

Age, height, weight, gender, nutritional habits, ecological requirements, the concentration of heavy metals in water and sediment, are an important determinant of accumulation of heavy metals in fish organs [6]. Also, common carp and goldfish including fish are omnivorous. They eat food from the water surface and bottom sediments [7].

The 96h LC_{50} tests is a way to find the toxicity substances and different elements [8]; In other words, with this method can be found amount of resistance and survival of different species in confronting with different concentrations of pesticides and other risk factors [9, 10, 11]; Whatever, LC_{50} combination is lower, the combined toxicity higher and more serious threat. Heavy metals have a low 96h LC_{50} [12].

The aquatic environments are the ultimate destination of environmental pollutants [13, 14]. Accordingly, have been conducted several studies on the toxicity of heavy metals (96h LC_{50}) on fishes; for example, Farkas *et al*. [15] studied environmental significance of heavy metal pollution in sediments of the River Po; Huang *et al.* [16]; Juric *et al*. [17]

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Determined of differential heavy metal and trace element accumulation in sterlet (*Acipenser ruthenus*) tissue from the Danube River in Serbia by ICP-OES; Chakeri *et al.* [18] Determined of heavy metal (lead and cadmium) in tissue of Indian mackerel (*Rastrelliiger Kanagurta*) in Persian Gulf and Yalsuyi and Vajargah [19] studied Acute toxicity of Silver nanoparticles in Roach (*Rutilus rutilus*) and Goldfish (*Carassius auratus*).

The aim of this study was to investigate the effects of acute cadmium concentration in survival and mortality of common Carp (*Cyprinus carpio)* and Goldfish (*Carassius auratus*) and Compare their sensitivity to each other.

2 Method and Material

Based on preliminary studies and laboratory facilities, 200 common carp (weight 43±4 gram) and 200 goldfish (weight 4/5±0/4 gram) prepared from Aquaculture farms of Golestan province and was transferred to laboratory (Veniro Lab., Department of Fisheries, Gorgan University of Agricultural Sciences and Natural Resources). After the transition, the fishes were kept in order to adapt to the laboratory for two weeks in tanks of 250 liters (230 liters filling volume). The feeding three meals a day and equivalent to 3% of the weight of the fish (food was Biomar). Density of fish in each tank was 40 fish and physicochemical conditions of the water in all tanks were similar (water temperature 26±3 ˚C, 7-9 ml/l dissolve Oxygen, 7.6 to 8 pH and Ammonia 0/05±0/01 ml/l).

After compatibility time, 147 fish were selected randomly and were divided into 7 treatments (0, 0.2, 1, 2, 6, 10 and 15 ml/L Cadmium chloride) and 3 repetitions (number of fish in each treatment was 21). Fish for 96 hours were exposed to different concentrations of cadmium chloride. The death count in intervals of 24, 48, 72 and 96 hours and the dead were removed from the tanks tests. The fish were not fed 16 hours before the main testing and during the testing. Physicochemical condition of the water at the time of testing the toxicity of cadmium, minus the concentration of cadmium chloride was similar the previous stage (Stage adaptations).

Acute toxicity tests were carried out according to Hotos and Vlahos [20], the nominal concentration of cadmium estimated to result in 50% mortality of fish within 24 h (24 h LC_{50}), 48 h, 72 h and 96 h was attained by probit analysis in confidence limit of 95% by software SPSS version 20 and toxicity was determined. To find the Correlation between different concentrations of cadmium on mortality was used Spearman test (2-tail).

3 Result and Discussion

Analysis data show a significant correlation between the concentration of cadmium chloride and mortality (Correlation is significant at the 0/01 level); with increasing concentrations of cadmium, mortality rates increased in both groups (Table 1).

Table 1: Total mortality of common Carp and Goldfish during testing the toxicity of cadmium (n=21, each concentration)

Concentration (ml/l)	Number of mortality							
	24h		48h		72h		96h	
	Goldfish	Com. Carp	Goldfish	Com. Carp	Goldfish	Com. Carp	Goldfish	Com. Carp
0.0	0	0	0	0	0	0	0	0
0.2	0	0	0	0	0	0	0	0
1.0	0	0	0	0	0	0	0	0
2.0	0	0	0	0	0	0	1	0
6.0	0	0	1	0	2	0	4	0
10.0	1	2	3	3	8	9	12	13
15.0	6	7	7	11	10	15	20	21

The result of this study indicated 96 h LC_{50} of Cadmium chloride for Goldfish and common Carp was 9/202 and 8/845 mg/L (Table 2); between 96 h LC_{50} of Cadmium in the common Carp compared to the Goldfish, there was significant difference ($P < 0.05$).

Table 2: Lethal concentration (96h $LC_{10\text{-}95}$) of Cadmium in fresh water fishes (common Carp and Goldfish)

Point	Concentration (mg/L)							
	24 h		48 h		72 h		96 h	
	Goldfish	Com. Carp	Goldfish	Com. Carp	Goldfish	Com. Carp	Goldfish	Com. Carp
LC_{10}	10.187	9.019	9.45	8.036	6.753	6.370	4.663	5.123
LC_{20}	14.238	12.434	12.089	10.145	9.207	7.835	6.221	6.179
LC_{30}	18.126	15.675	13/993	12.002	10.976	9.097	7.345	7.074
LC_{40}	22.279	19.105	15.619	13.885	12.487	10.334	8.305	7.940
LC_{50}	27.017	22.986	17.139	15.846	13.900	11.643	9.202	8.845
LC_{60}	32.762	27.656	18.659	18.122	15.313	13.118	10.100	9.854
LC_{70}	40.269	33.707	20.285	20.921	16.825	14.903	11.060	11.060
LC_{80}	51.265	42.491	22.189	24.750	18.594	17.303	12.183	12.661
LC_{90}	71.653	58.584	24.828	31.246	21.047	21.283	13.741	15.272
LC_{95}	94.475	76.377	27.008	37.879	23.073	25.252	15.0228	17.829

Fishes are exposed to different concentrations of Cadmium chloride showed Clinical signs; such as anxiety, blurred color, increased mucus secretion and death with open mouth.

Heavy metals are one of the main groups of pollutants in aqueous environments. Great part of this metal are due to human activities enter the aquatic environment [21]. Pollutants in addition reducing chance of survival of fish, can led to change their behavior such as swimming patterns [22]. For this season, monitoring of the toxic heavy metals, it is important for scientists, nutrition, medical and environmental researchers.

Previous studies showed level 96h LC_{50} of Cadmium for aquatic species depending on the aquatic species type or metal type is different; for example, Spehar [23], reported level 96h LC_{50} of Cadmium for *Mugil cephalus* and *Jordanella floridae* had set 28.0 and 2.5 ml/l, respectively. Das and Banerjee [24], stated 96h LC_{50} of Cadmium 300.0 and 175.0 ml/l for *Lebio rohita* and *Heteropneustes fossilis*, respectively; finally, The results of our study showed cadmium was high toxic for common Carp (*Cyprinus carpio*) and Goldfish (*Carassius auratus*). The Lethal Concentrations (96h LC_{50}) cadmium for Goldfish was 9/202 ml/l and for common Carp was 8/845 mg/l. Common carp was more sensitive to cadmium toxicity.

Pandey and Madhuri [25] Studied on the heavy metal causing toxicity in animal and fishes; for this purpose they studied the such as Hg, Pb, Cu and Cd concentrations in the environment, fish and other animals. They said the toxicity of heavy metals depend fish species. This section of their results was similar our study.

Studies Chakeri *et al.* [18] Determined of heavy metal (lead and cadmium) concentrations in liver and muscle tissue of Indian mackerel (*Rastrelliiger Kanagurta*) in Persian Gulf. they reported were observed clinical signs, such as anxiety, increased mucus secretion and finally death with open mouth in heavy metal poisoning. Also, they stated a different species of fish with different sensitivity towards heavy metal toxicity. The results of our study were consistent with the results of their study.

Vinodhini and Narayanan [26] studied impact of toxic heavy metals on the hematological parameters in common Carp (*Cyprinus Carpio).* Result of their study showed heavy metal poisoning can be lead to anxiety, increased mucus secretion and death. The results of present study were similar with the results of their study.

Smet and Blust [27] studied stress responses and changes in protein metabolism in Carp (Cyprinus carpio) during Cadmium Exposure. Result of their study demonstrated Cadmium poisoning can be leads to change in metabolism of protein and amino acid in Gills, Liver and Kidney; also, they stated Accumulation of heavy metals in these organs and protein metabolism disorder lethal to fishes in high concentrations (20 µM). Finally they reported cadmium was high toxic for Carp. Result of our study was similar to their study.

Heavy metals are one of the main groups of pollutants in aqueous environments. Great part of this metal are due to human activities enter the aquatic environment [21]. Monitoring of the toxic heavy metals, it is important for scientists, nutrition, medical and environmental researchers.

Compare our results with the results of previous studies showed that the toxicity of cadmium (96h LC_{50}) from 2/91-4/28 ml/l for *Corophium orientate* until the 1/85-5/30 for *Corophium Volutator* Depending on the species of Aquatic, nutrition and living environment is different [28, 29, 30].

Aquatic breed can be used as a biological indicator for the detection extent of water pollution. This requires further study and more pervasive. Evaluation of toxicity of other heavy metals on the chances of survival and mortality can be to study further. Previous studies have shown that several heavy metals in natural environments can be seen at the same time [25]; accordingly, the study of the interaction effect of two or more heavy metals on the chances of survival, their toxicity and accumulation can be subject of future studies.

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Reference

1. Di Giulio, R.T. & Hinton, D.E. (2008). The Toxicology of Fishes. Taylor & Francis. pp. 319–884.
2. Hedayati, A., Safahieh, A., Savar, A. & Marammazi, J.G., (2010). Detection of mercury chloride acute toxicity in Yellowfin sea bream. World J. Fish. Mar. Sci., 2(1), 86-92.
3. Kalay, M.; Ay, P. & Canil, M. (1999). Heavy metal concentration in fish tissues from the northeast Meditereansea. Bull. Environ. Contam. Toxicol., 63, 673-671.
4. Sörensen, E.M.(1991). Cadmium. *In* ''Metal Poisoning in Fish,''. CRC Press, Boston. pp. 175-234.
5. Sany, B.T, Sulaiman, A.H., Monazami G.H. & Saleh, A. (2011). Assessment of Sediment Quality According To Heavy Metal Status in the West Port of Malaysia. World Acad. Sci. Engin. Tech., 5(2), 111-115.
6. Demirak, A., Yilmaz, F., Tuna, A.L. & Ozdemir, N. (2006). Heavy metals in water, sediment and tissues of Leuciscus cephalus from a stream in southwestern Turkey. Chem., 63(9), 1451-1458.
7. Satari, m., Shahsavani, D. & Shafiei S., (2007). Systematic ichthyology. Haqshenas Publications, Rasht, Iran. 502 p. (In Persia)
8. Hedayati, A., Yalsuyi, A.M. & Vajargah, M.F. (2017). Acute toxicity test as a method to assessment toxicity of pollutants. Ann. Aquac. Res., 4(2); 1036.
9. Chorehi, M. M., Ghaffari, H., Hossaini, S.A., Niazie, E.H.N., Vajargah, M.F. & Hedayati, A. (2013). Acute toxicity of Diazinon to the Caspian vimba, *Vimba vimba persa* (Cypriniformes: Cyprinidae). Int. J. Aqua. Biol., 1(6), 254-257.
10. Hedayati, A., Vajargah, M.F., Yalsuyi A.M., Abarghoei, S. & Hajiahmadyan, M. (2014). Acute toxicity test of pesticide Abamectin on common carp (Cyprinus carpio). J. Coast. Life Med., 2(11), 841-844.
11. Vajargah, M.F., Hedayati, A., Yalsuyi A.M., Abarghoei S., Gerami, M.H. & Farsani, H.G. (2014). Acute toxicity of Butachlor to Caspian Kutum (Rutilus frisii Kutum Kamensky, 1991). J. Environ Treat. Tech., 2(4), 155-157.
12. Johnston, E.L., Keough, M.J. & Qian, P.Y. (2002). Maintenance of species dominance through pulse

disturbances to a sessile marine invertebrate assemblage in Port Shelter Hong Kong. Mar. Ecol. Prog. Ser., 226, 103–114.
13. Vajargah, M.F. & Hedayati, A. (2014). Toxicity of tricholorofon on four viviparous fish: Poecilia latipinna, Poecilia reticulate, Gambusia holbrooki and helleri (*cyprinodontiformas: poecilidae*). J. Cost. Life Med., 2(7), 511-514.
14. Vajargah, M.F., Hossaini S.A. & Hedayati A. (2013). Acute toxicity test of two pesticides Diazinon and Deltamethrin on spirlin (*Alburnoides bipunctatus*) larvae and fingerling. J. Toxicol. Environ. Heal. Sci., 5(6), 106-110.
15. Farkas, A., Claudio, E. & Luigi, V. (2007). Assessment of the environmental significance of heavy metal pollution in sediments of the River Po. Chem., 68, 761-768.
16. Huang, W.B. (2003). Heavy Metal Concentration in the Common Benthic Fishes Caught from the coastal Waters of Eastern Taiwan. J. Food. Drug. Anal., 11(4), 324-330.
17. Juric, I., Visnjic-Jeftic, Z., Gorcin Cvijanovic, G., Zoran Gacic, Z., Ljubinko ovanovic, L., Skoric, S. & Mirjana Lenhardt, M. (2011). Determination of differential heavy metal and trace element accumulation in liver, gills, intestine and muscle of sterlet (*Acipenser ruthenus)* from the Danube River in Serbia by ICP-OES. J. Microchem., 91, 77–11.
18. Chakeri, R., Sajadi, M.M., Kamrani, E. & Aghajari, N. (2015). Determination of heavy metal (lead and cadmium) concentrations in liver and muscle tissue of Indian mackerel (*Rastrelliiger Kanagurta*) in Persian Gulf. Iran. Sci. Fish. J., 24(2), 115-125.
19. Yalsuyi, A.M. & Vajargah, M.F. (2017). Acute toxicity of Silver nanoparticles in Roach (*Rutilus rutilus*) and Goldfish (*Carassius auratus*). J. Environ Treat. Tech., 5(1), 1-4.
20. Hotos, G,N. & Vlahos, N. (1998). Salinity tolerance of *Mugil cephalus* and *Chelon labrosus* (Pisces: Mugilidae) fry in experimental conditions. Aquac., 167:329-338.
21. Humtsoe , N., Davoodi, R., Kulkarni, B.G. & Chavan, B. (2007). Effect of arsenic on the enzymes of the robu carp (*Labio rohita*). Raffles Bulletin of Zoology., 14, 17-19.
22. Yalsuyi, A.M. & Vajargah, M.F. (2017). Recent advance on aspect of fisheries: a review. J. coast. Life. med., 5(4), 141-148.
23. Spehar, R.L. (1976). Cadmium and zinc toxicity in flag fish, Jordanella floridae. J. Fish. Res. Board Can., 33, 1939-1945.
24. Das, K.K. & Banerjee, S.K. (1980). Cadmium toxicity in fishes. Hydrobiol., 75, 117-121.
25. Pandey, G. and Madhuri, S.(2014). Heavy Metals Causing Toxicity in Animals and Fishes. AVFS., 2(2), 17-23.
26. Vinodhini, R. & Narayanan, M. (2009). The impact of toxic heavy metals on the hematological parameters in common Carp (*Cyprinus Carpio).* Iran. J. Environ. Health. Sci. Eng., 6 (1); 23-28.
27. Smet, D.H. & Blust, R. (2011). Stress responses and changes in protein metabolism in Carp, Cyprinus carpio during cadmium exposure. Ecotox. Environ. Saf., 48, 255-262.
28. Ciarelli, S. (1994). Guideline for conducting 10-day static sediment toxicity tests using marine or estuarine amphipods. Report from the tidal Water Division, Middelburg, Netherlands. Report RIKZ-94.031.
29. Onorati, F., Bigongiari, N., Pellegrini, D. & Giuliani, S. (1999). The suitability of Corophium orientale (Crustacea, Amphipoda) in harbour sediment toxicity bioassessment. Aquat. Ecosys. Heal. 2 (4), 465–473.
30. Chen, C.Y. & Folt, C.L. (2000). Bioaccumulation and diminution of arsenic and lead in a freshwater food web. Environ. Sci. Technol., 34, 3878-3884.