

**TOXICITY EFFECTS OF CADMIUM IN GRASS CARP
(CTENOPHARYNGODON IDELLA) AND BIG HEAD CARP
(HYPOPHTHALMICHTHYS NOBILIS)**

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DOI: 10.1515/trser-2017-0004

KEYWORDS: Fish, Cadmium Chloride, Toxicity, 96 h LC₅₀.

ABSTRACT

Heavy metals can threaten ecosystem health and of food security. The purpose of percent study was evaluating the sensitivity of grass carp (*Ctenopharyngodon idella*) and Big head carp (*Hypophthalmichthys nobilis*) exposed to cadmium Chloride. To this end, fishes were exposed different concentrations of cadmium in range of cadmium chloride (0, 0.2, 1, 2, 6, 10 and 15 ml/l). The mortality of treatments was calculated at intervals of 24, 48, 72, 96 hours. Analysis of the data showed the 96 h LC₅₀ of cadmium chloride for grass carp was 4.164 ml/l and for Big head carp was 5.590 ml/l. The results of this study showed that Cadmium is highly toxic for freshwater species.

RESUMEN: Evaluar la toxicidad del cadmio en la carpa de hierba (*Ctenopharyngodon idella*) y en la carpa de cabeza grande (*Hypophthalmichthys nobilis*).

Los metales pesados pueden amenazar la salud de los ecosistemas y la seguridad alimentaria. El propósito del estudio porcentual fue evaluar la sensibilidad de la carpa herbívora (*Ctenopharyngodon idella*) y la carpa cabezona (*Hypophthalmichthys nobilis*) frente al cadmio. Con este fin, los peces fueron expuestos a diferentes concentraciones de cadmio en un rango de 0, 0,2, 1, 2, 6, 10 y 15 mg/l de cloruro de cadmio. La mortalidad en los tratamientos se calculó a intervalos de 24, 48, 72 y 96 horas. El análisis de los datos mostró que la LC₅₀ de Cadmio (cloruro de cadmio) para la carpa herbívora a las 96 h fue de 4.164 mg/l y para la carpa cabezona de 5.590 mg/l. Los resultados de este estudio mostraron que el cadmio es altamente tóxico para las especies de agua dulce.

REZUMAT: Evaluarea toxicității cadmiului la amur (*Ctenopharyngodon idella*) și la novac (*Hypophthalmichthys nobilis*).

Metalele grele pot pune în pericol sănătatea mediului și securitatea alimentară. Prezentul studiu a avut ca obiectiv evaluarea sensibilității amurului (*Ctenopharyngodon idella*) și novacului (*Hypophthalmichthys nobilis*) la cadmiu. În acest scop, peștii au fost expuși la diferite concentrații de cadmiu sub formă de clorură (0, 0,2, 1, 2, 6, 10 și 15 ml/l). Mortalitatea indusă de administrări a fost calculată la intervale de 24, 48, 72 și 96 ore. Analiza datelor arată că LC₅₀ a cadmiului (clorură de cadmiu) la amur după 96 ore a fost 4/164 ml/l, iar la novac a fost de 5/590 ml/l. Rezultatele studiului arată faptul că acest metal este deosebit de toxic pentru speciile de apă dulce.

INTRODUCTION

Group of metal elements for example Cu, Fe, Mn and Zn are necessary for the survival of living things. Another group of metals are heavy metals. This group of metals, unlike the other group are the non-essential (Di-Giulio and Hinton, 2008; Hedayati et al., 2010). The heavy metals combined with the organic molecules will accumulate in the tissues. This process, is eventually leading to contamination of food and destruction of food chain (Kalay et al., 1999); the heavy metal accumulates in the tissue of living organisms and, moving along the food chain, is causing a threat to food safety. Previous studies have shown that some of the human activities such as the oil extraction dispose industry and hospital waste are leading to increased concentrations of heavy metals such as Hg and Cd in the environment. (Tavakoly Sany et al., 2011)

Age, height and weight, gender nutritional habits, the environmental requirements, the concentration of heavy metals in sediment and water, an important determinant of the organs accumulation of heavy metals in fish (Demirak et al., 2006). As well as grass carp and bighead carp are omnivorous fish; they eat their foods from the water surface and bottom sediments (Satari et al., 2007).

The 96 h LC50 tests is a method for finding the toxicity of various elements; in other words, using this method, the amount of strength and survival of different species, in face of different concentrations of pesticide and other risk factors, can be determined (Hedayati et al., 2014); Whenever the concentration of 96 h LC50 is lower, the toxicity is stronger. Heavy metals have a low 96h LC50 (Johnston et al., 2002).

Until now, few studies have been done on the toxicity of cadmium (96 h LC50) on freshwater fishes, especially grass carp (*Ctenopharyngodon idella*) and bighead carp (*Hypophthalmichthys nobilis*). Most studies were detected concentrations of heavy metals in the tissue of marine fish. For example, Farakas et al., 2003; Huang et al., 2003; Juric et al., 2011; Askary Sary, 2012 and Chakeri, 2015. The purpose of this study was to evaluate the effects of acute of cadmium concentrations of on mortality rates and survival of the two species of freshwater fish (grass carp and big head carp).

MATERIAL AND METHODS

According to primary survey and laboratory facilities, 250 grass carp (weight 40 ± 4 g) and 250 Big head carp (weight 12 ± 2.6 g) were prepared from the fish farms in Golestan province and moved to the laboratory (Veniro wet lab, Department of Fisheries, Gorgan University of Agricultural Sciences and Natural Resources). After transferring the fishes to the lab, they have been kept in the 280 liters tanks for the two week (250 liters filling volume) in order to adapt of fish to lab condition. During this time, the fish have been fed three meals a day and equivalent to 3% of the weight of the fish (Biomar food). The density of fish in each tank was 50 and physicochemical conditions were similar in all tanks (water temperature $28 \pm 2^\circ\text{C}$, 7-8 ml/l dissolved oxygen, 7/4 to 8/1 pH and ammonia $0/04 \pm 0/03$ ml/l).

After acclimating, 147 fish were selected randomly and were split into seven treatments (0, 0.2, 1, 2, 6, 10 and 15 ml/l Cadmium chloride) and three repetitions (number of fish in each treatment was 21). Fish were exposed for 96 hours 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 of test. The fishes were not fed 18 hours before the main test and during the main test. The 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 of Cadmium was estimated based on Hotos and Vlahos; lethal concentration of Cadmium (for 50% of the population) in intervals of 24, 48, 72 and 96 hours (24 h LC50), 48 h, 72 h and 96 h were estimated through probit test with a 95% confidence. To find the correlation between different concentrations of cadmium on mortality Spearman test (2-tail) was used.

RESULTS AND DISCUSSION

Specific endpoint results of mortality effects of cadmium for studied fishes are in table 1.

Table 1: Mortality effects of cadmium for studied fish.

Concentration (mg/l)	Number of mortality							
	24 h		48 h		72 h		96 h	
	Grass carp	Big head	Grass carp	Big head	Grass carp	Big head	Grass carp	Big head
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
2	0	0	0	0	1	0	4	0
6	3	0	5	1	7	3	14	7
10	7	5	11	9	18	13	21	21
15	8	10	15	15	21	21	21	21

Also, the results showed 96 h LC50 of cadmium for grass carp was 5.264 mg/l and for bighead carp was 6.590 mg/l (Tab. 2); there was significant difference between 96 h LC50 of cadmium in the grass carp compared to the bighead carp, ($P < 0.05$).

Table 2: Lethal concentration of cadmium (96 h LC₁₀₋₉₅) for grass carp and big head carp.

Point	Concentration (mg/l)							
	24 h		48 h		72 h		96 h	
	Grass carp	Big head	Grass carp	Big head	Grass carp	Big head	Grass carp	Big head
LC10	6.748	8.628	4.911	6.795	3.793	5.791	2.530	5.096
LC20	9.635	10.887	6.976	8.567	4.937	6.889	3.468	5.140
LC30	11.717	12.324	8.465	9.844	5.762	7.380	4.045	5.160
LC40	13.496	13.551	9.737	10.955	6.467	7.657	4.143	5.334
LC50	14.159	13.698	9.926	10.995	6.126	7.989	4.164	5.590
LC60	16.822	15.845	12.115	12.975	7.785	9.621	5.804	6.846
LC70	18.600	17.072	13.387	14.066	8.490	10.297	6.382	7.119
LC80	20.682	18.805	14.876	15.343	9.315	11.088	7.059	7.440
LC90	23.570	20.500	16.941	17.114	10.459	12.186	7.998	7.884
LC95	25.956	22.145	18.646	18.577	11.404	13.092	8.773	8.250

Fish, in various concentrations of cadmium chloride, had symptoms of with cadmium poisoning, such as: anxiety, colour vision, increased mucus secretion and death with the open mouth.

Toxic heavy metals are the main group of pollutants in aquatic environments; a large portion of this metal enters aquatic environment due to the human activities (Humtsoe et al., 2007). Monitoring the heavy metals toxicity was important for scientists, nutrition, medical and environmental researchers.

The results of this study showed that cadmium was toxic for grass carp and bighead carp. Lethal concentrations of cadmium (96 h LC₅₀) for grass carp was less than for bighead carp; this difference, in addition to differences in the two species could be due to their size.

Pandey and Madhuri (2014) examined heavy metal toxicity in animals and fish; for this aim they studied on Hg, Pb, Cu and Cd concentrations in the environments, fishes and other animals. They said that heavy metal toxicity depends on the fish species and their habits. This section of their results was similar to present study.

Studies Chakeri et al. (2013), Vinodhini and Narayanan (2009) and Spehar (1976) found that heavy metal poisoning causes anxiety, increased mucus secretion and eventually death. Also, they said different fish species, had different sensitiveness to heavy metals. The results of the study were similar to our study.

Comparing the present study results with the results of previous studies, the toxicity of cadmium (96 h LC₅₀) had been showed from 1.85-5.30 for *Corophium volutator* until the 2.91-4.28 ml/l for *Corophium orientate*, depending on the species, nutrition and the environment (Ciarelli, 1994; Onorati et al., 1999; Chen and Folt, 2000).

Level 96 h LC50 of Cadmium for aquatic species depending on the aquatic species type or metal type is different; for example, Spehar (1976) Level 96 h LC50 of Cadmium for *Mugil cephalus* and *Jordanella floridae* had set 28.0 and 2.5 ml/l, respectively. Das and Banerjee (1980) reported 300.0 and 175.0 ml/l Cadmium for *Lebio rohita* and *Heteropneustes fossilis*, respectively. Eventually, Smet and Blust (2011), expressed, after four weeks, the whole population of common carp that were exposed to cadmium (two ml/l) for 96 hours were died.

CONCLUSIONS

According to the results of this study, grass carp and bighead carp species can be used as biological indicators, however his aim requires further study and higher pervasive. 96 h LC₅₀ of cadmium chloride for grass carp was 4.164 ml/l and for big head carp was 5.590 ml/l that showed cadmium is highly toxic for this species. The effect of two or more heavy metals on the health of fish and toxicity of heavy metal could be the fields of next studies.

ACKNOWLEDGEMENTS

The study was done by technical and scientific support of Gorgan University of Agricultural Sciences and Natural Resources. We thank the efforts of Mr. Jafar A. and all those who helped us.

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