

ACCUMULATION OF LEAD AND CADMIUM IN TISSUES OF *CYPRINUS CARPIO* COLLECTED FROM CAGES OF AL-GHARRAF RIVER /THI QAR / IRAQ

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ABSTRACT

This study was aimed to investigate the lead and cadmium in water and in fish samples collected from three sites of Gharraf River at Thi Qar from September 2020 until April 2021. Results showed that (Pb) in river water ranged 0.156 - 4.306µg/l and the (Cd) 0.074 - 0.523 µg/l which recorded a significant differences among all sites as well as among all seasons. In addition the concentrations of Pb in some tissues of *Cyprinus carpio* ranged 0.069 - 4.98µg/g in muscles and kidney respectively, while Cd ranged 0.038 - 1.46 µg/g in muscles and kidney respectively. The study also showed a significant differences in Pb concentrations in fish tissues among all sites during seasons and recorded a significant differences in the summer compared with other season for Pb and Cd. A significant difference was also found in Pb and Cd concentrations between cages fish and the wild fishes for all seasons. The study proved that the water of the Al-Gharraf River is of low toxicity and less than the Iraqi and international standards, and the accumulation of Pb and Cd in the muscles of fish was less than the limits of the Federal Agency for Environmental Protection and the World Health Organization.

Keywords: bioaccumulation, environment, heavy metals, pollution, wild fish

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تراكم الرصاص والكاديوميوم في انسجة *Cyprinus carpio* المصيده من اقفاص نهر الغراف / ذي قار / العراق

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المستخلص

اجريت الدراسة الحالية للكشف عن الرصاص والكاديوميوم في المياه وفي عينات الاسماك التي تم جمعها من ثلاث مواقع لنهر الغراف في ذي قار من ايلول 2020 حتى نيسان 2021. اظهرت النتائج ان تركيز الرصاص في مياه النهر تراوحت بين 0.156 - 4.306 ميكروغرام/لتر والكاديوميوم بين 0.074 - 0.523 ميكروغرام/لتر اذ سجلت فروق معنوية بين جميع المواقع كذلك بين جميع المواسم. تراوح تركيز الرصاص في بعض انسجة اسماك الكارب الشائع بين 0.069 - 4.98 ميكروغرام/غرام في العضلات والكلى على التوالي، بينما تراوح تركيز الكاديوميوم بين 0.038 - 1.46 ميكروغرام/غرام في العضلات والكلى على التوالي. كما سجلت الدراسة فروقا معنوية في تركيز الرصاص في انسجة الاسماك بين جميع المواقع خلال جميع المواسم وسجلت فروق معنوية في الصيف مقارنة ببقية المواسم في تركيز الرصاص والكاديوميوم. كما تم تسجيل فروقا معنوية في تركيزي الرصاص والكاديوميوم بين اسماك الاقفاص واسماك النهر خلال جميع المواسم. أثبتت الدراسة أن مياه نهر الغراف منخفضة السمية وأقل من المعايير العراقية والعالمية، ومعدل تراكم الرصاص والكاديوميوم في عضلات الأسماك كان أقل من حدود الوكالة الاتحادية لحماية البيئة. ومنظمة الصحة العالمية.

الكلمات المفتاحية: التراكم الحيوي، البيئة، المعادن الثقيلة، التلوث، الاسماك البريه.

INTRODUCTION

Rivers and marshes are the main sources of water in Iraq (3). The Al-Gharraf River is considered one of the main sources for supplying the governorates of Wasit and Thi Qar with fresh drinking water, in addition to its agricultural importance (3). Pollution is the entry of foreign materials such as dirt, waste and chemicals into the environment from the air, dust or water, which have a negative and toxic effect on all living organisms (10). Environmental pollution is considered one of the most important sources of the main threat facing human society due to the destruction and pollution caused by chemicals and heavy metals, and it has become a source of great concern (5). Water pollutions are the main cause of heavy metals bioaccumulation in the various organs and tissues of freshwater fish (2). Freshwater fish is widely used as a vital indicator of pollution in the aquatic environment(7). Heavy metals are considered one of the most prevalent environmental pollutants because they are dangerous, persistence and not degradation (12). Cadmium and lead are two heavy metals that are toxic to human health and dangerous to the environment (9). Cadmium is one of the

metals that are few in nature and increase as a result of human activity, whether agricultural or industrial (1). It also helps to stimulate and create free radicals in many tissues and organs (14). Because of the few studies that relate to the determination of heavy metals in cage particularly in Gharraf River fish, therefore the present study was complemented to assessment of seasonality variations of some ecological proprieties of water and detection the accumulation of Pb and Cd in water samples and in Fish organs (gills, muscles and kidney).

MATERIALS AND METHODS

Study area

The sites of the three cages for this study are located on the Al-Gharraf River, one of the branches of the Tigris River, which extends from its source, north of Al-Kut dam to its mouth in marsh Al-Hammar in Thi Qar, with estimated 230 Km. In addition to considering the river fishes a fourth site for study. The distance between the site of cages and another site is about 5Km. The first site is located at the village of Al-Sada Al-Buhalala, the second site is at the village of Al-Bu Alian, and the third site at the village of Albu Hawan, and the fourth site is the river itself (Fig.1).

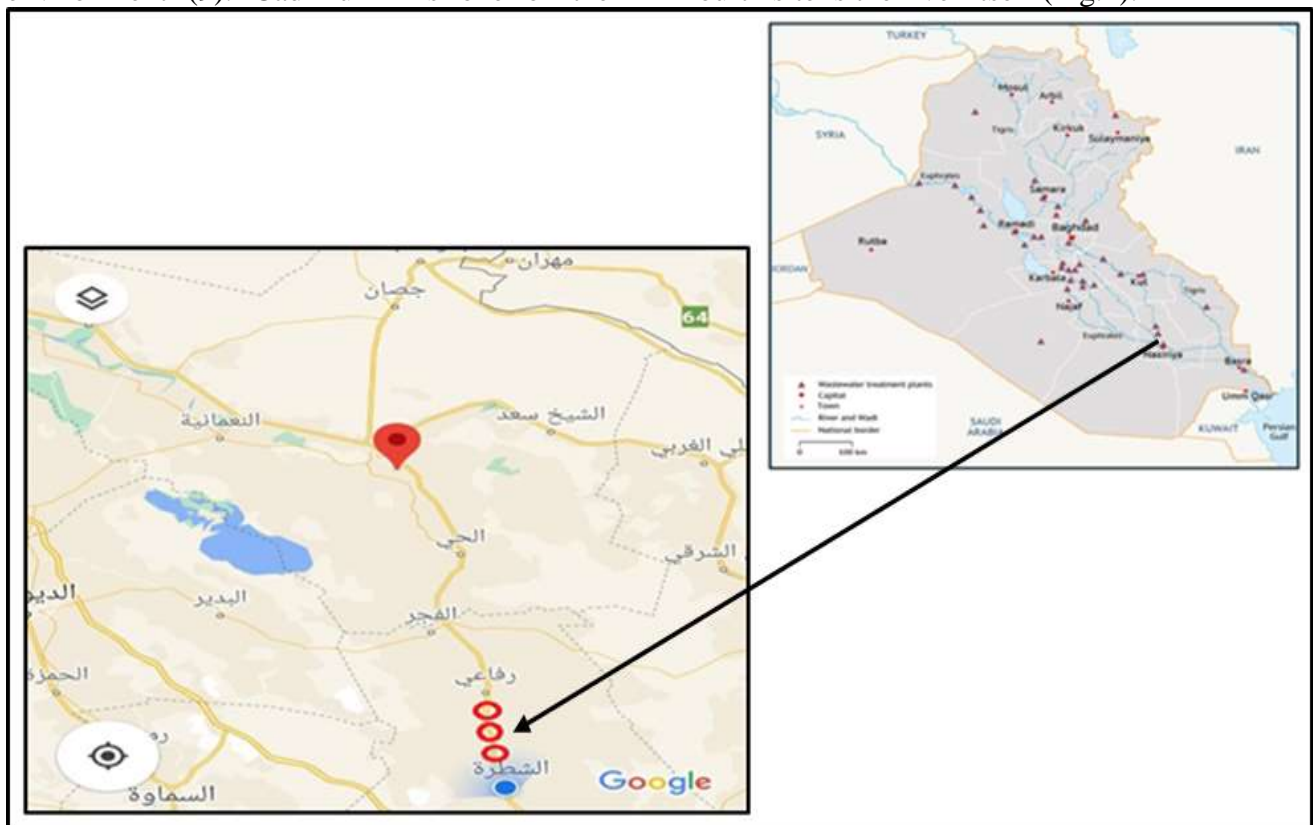


Figure 1. Map of the study area showed the study sites

Collection of fishes and water samples

Water samples were collected in washed and clean bottles about 2 liter from each site and sent to the Environmental Pollution Laboratory at Thi Qar University, College of Science, for the purpose of the filter and preparing them for analysis using an atomic absorption spectrophotometer device. In addition, 160 common carp were collected from September 2020 until April 2021 during the four study seasons from the three cage sites and from the river as a fourth site, with different weights and lengths. Fish samples were washed, dissected, and the organs of the gills, muscles and kidney were separated and dried, then they are crushed and prepared for detection of lead and cadmium using an atomic absorption spectrophotometer device (Japan).

Samples analysis

The water samples were analyzed to determine the concentrations of dissolved lead and cadmium in the filtered cages water use the Riley and Taylor method (21). After preparing the samples, the analysis was carried out with, atomic absorption spectrophotometer device the results expressed by $\mu\text{g/l}$. Fish samples (gills, muscles, and kidney) are digested according to Moopam's method (15). After preparing the samples, they are analyzed with atomic absorption spectrophotometer device.

Statistical Analysis

The Statistical Analysis System- SAS (23) program was used to detect the effect of difference parameters in study. Two-way ANOVA with Least significant differences (LSD) post hoc test was performed to assess significant difference among means. $P \leq 0.05$ was considered statistically significant. Least significant difference –LSD test (Analysis of Variation-ANOVA) was used to significant compare between means in this study.

RESULTS AND DISCUSSION

Water quality and analysis of heavy metals

Water quality and analysis of heavy metals in water samples: Water temperature ranged between 11.30 - 30°C, salinity 0.532 – 0.627g/l, pH 7.46 – 7.75, dissolved oxygen 6.20 - 8mg/l and biological oxygen demand 1.10 - 4mg/l. The present study recorded a significant difference ($P \leq 0.05$) among sites in the level of salinity during the summer and winter seasons. Also the pH level during the autumn season, as well as the level of DO during the summer, autumn and winter seasons, and in the level of the BOD during all seasons. No significant difference ($P > 0.05$) was recorded in the level of water temperature among sites (Tab.1). The average concentration of dissolved lead in the water was between 0.165 - 4.306 $\mu\text{g/l}$ and cadmium 0.074 – 0.523 $\mu\text{g/l}$ (Tab. 2). The present study recorded a significant difference $P \leq 0.05$ in the concentration of dissolved lead and cadmium in water among four sites during each season, as well as among seasons for each site. The high level of lead at site 2 and during all seasons is due to the proximity of the site to the dam of the Badaa, which means that the movement of the Water current is weak in addition to the presence of 4 giant projects for filtering drinking water north of the site, which contain huge generators to generate electricity that use diesel fuel and all are located on the banks of the river, it causes pollution of the river water with fuel residues (13). The results of the present study showed a positive relationship between lead and cadmium accumulation with water temperature and salinity, and a negative relationship with pH and DO, and this results is in consistent with study of Oudah (18) and Al-Rudainy and Al-Samawi(6).

Table 1. Physical and chemical properties of water ((Mean±SD)

Season	Site	Water temp. °C	Salinity g/l	Water pH	Dissolved oxygen mg/l	Biological oxygen demand mg/l
Summer	1	30.00a±1.0	0.623a±0.003	7.46a±0.02	6.20c±0.06	2.80b±0.05
	2	28.99a±0.4	0.627a±0.011	7.51a±0.11	7.20a±0.15	1.60d±0.02
	3	29.13a±0.6	0.620a±0.003	7.51a±0.06	6.40bc±0.05	4.00a±0.10
	4	29.00a±0.5	0.611b±0.011	7.36a±0.11	6.54b±0.23	2.00c±0.15
	LSD	1.29 NS	0.0155	0.157 NS	0.269	0.178
Autumn	1	22.40a±0.4	0.609a±0.006	7.67a±0.07	7.10c±0.07	1.80b±0.03
	2	22.00a±0.5	0.601a±0.011	7.69a±0.09	8.00a±0.13	1.40c±0.08
	3	22.100a±0.6	0.606a±0.006	7.63a±0.13	6.90d±0.05	2.20a±0.02
	4					
	LSD	21.80a±0.7	0.590a±0.010	7.33b±0.08	7.33b±0.03	1.50c±0.10
Winter	1	1.05 NS	0.016 NS	0.178	0.145	0.119
	2	11.40a±0.6	0.523a±0.003	7.80a±0.10	7.60a±0.15	1.40a±0.02
	3	11.30a±0.8	0.533a±0.020	7.77a±0.06	7.50a±0.05	1.10b±0.10
	4	11.60a±0.4	0.532a±0.002	7.75a±0.05	7.10b±0.10	1.30a±0.03
	LSD	11.20a±0.2	0.510b±0.010	7.65a±0.15	7.28b±0.13	1.40a±0.07
Spring	1	0.94 NS	0.021	0.188 NS	0.21	0.119
	2	21.70a±0.5	0.534a±0.004	7.75a±0.05	7.50a±0.07	1.60a±0.10
	3	21.50a±0.3	0.534a±0.014	7.73a±0.08	7.40a±0.05	1.20b±0.02
	4	21.20a±0.4	0.532a±0.005	7.70a±0.07	7.50a±0.02	1.50a±0.06
	LSD	21.40a±0.3	0.520a±0.009	7.74a±0.04	7.40a±0.15	1.30b±0.12
		0.856 NS	0.016 NS	0.119 NS	0.163 NS	0.157

Different column letters mean significant differences $P \leq 0.05$

Table 2. Concentrations of lead and cadmium $\mu\text{g/l}$ (Mean \pm SD) dissolved in water

Metal	Site	Summer \pm SD	Autumn \pm SD	Winter \pm SD	Spring \pm SD
Pb	1	2.723c±0.003	1.229d±0.009	0.559c±0.009	0.228c±0.005
	2	4.306a±0.020	2.921a±0.006	1.177a±0.017	0.372a±0.002
	3	2.183d±0.003	1.368c±0.018	0.261d±0.006	0.156d±0.006
	4	3.060b±0.020	1.830b±0.30	0.660b±0.10	0.240b±0.002
	LSD	0.027	0.034	0.021	0.007
Cd	1	0.436b±0.006	0.385b±0.005	0.100c±0.003	0.085b±0.005
	2	0.523a±0.010	0.420a±0.010	0.135a±0.005	0.108a±0.008
	3	0.385c±0.005	0.325c±0.004	0.090d±0.002	0.074c±0.004
	4	0.440b±0.020	0.370b±0.010	0.110b±0.007	0.090b±0.002
	LSD	0.022	0.015	0.008	0.009

Different column letters mean significant differences $P \leq 0.05$

Analysis of heavy metals in tissues

The concentrations of Pb and Cd were measured in the organs of the fish of the three cage sites and in fish samples of the river as a fourth site. Results revealed that metal accumulation in the fish tissue was determined with the following order kidney > gills > muscles. The average of the lowest concentration of Pb was $0.069\mu\text{g/g}$ in muscles at site 1 during the spring season and the highest was $4.98\mu\text{g/g}$ in kidney at river site during the summer season. Also the lowest Cd average was in the muscles at site 1 during the spring season $0.038\mu\text{g/g}$ and the highest level of Cd was in the kidney at site 2 during the summer $1.46\mu\text{g/g}$ (Tab.3). Statistical analysis recorded a significant difference ($P \leq 0.05$) among sites also among summer season and the rest seasons. The concentration of Pb and

Cd were higher in the longer lengths of fish. This because the accumulation of metals in fish tissues depends on many factors, including age and size (19). The present study also showed that the high concentration of Pb in the summer and autumn and its decrease in the winter and spring. This could be due to the high water temperature, increase of its evaporation, high decomposition of organic matter and consequently the high level of lead in the water and then fish tissue (11,22). Decrease in the concentration of lead in winter and spring is due to the high water level attributed to the rain that caused the increase in the dilution of minerals and also the increase in the growth of plants that might contribute to the absorption of these minerals (4). Also probably due to the increased growth and spread of the hyacinths plant in recent years,

which plays an important role in the absorption of these metals (20). The study also showed that the highest concentration of Pb and Cd is in the kidney then the gills and the muscles because mineral accumulated at the highest level in the metabolic organs, including the liver and kidney (16,17). The common carp in the river outperformed the carp in the cages in the accumulation of Pb and Cd in the organs. The reason may be due to the difference in the style of the diet and to the difference in the nature of the water environment contents, such as sediments and aquatic plants, in addition to the difference in

the age stage and thus the difference in the duration of exposure to these minerals. As well as common carp by their nature are gluttonous fish that feed on sediments, mud, plant and animal materials, which makes them more vulnerable to the accumulation of minerals and these sources of nutrition are more available in river fish than cage fish (8, 13, 23). The current study proved that fish is an important indicator for detecting heavy metal pollution of water. Also pollution of water and aquatic organisms varies from one region to another, according to the presence of pollution sources and environmental awareness.

Table 3. Concentrations of Lead and cadmium $\mu\text{g/g}$ (Mean \pm SD) in different fish organs

Season	Site	Lead			Cadmium		
		Gills (M \pm SD)	Muscles (M \pm SD)	Kidneys (M \pm SD)	Gills (M \pm SD)	Muscles (M \pm SD)	Kidneys (M \pm SD)
Summer	1	1.76c \pm 1.01	1.70b \pm 0.96	1.79c \pm 1.00	1.12a \pm 0.38	1.01a \pm 0.33	1.14a \pm 0.37
	2	3.31b \pm 2.37	2.95b \pm 2.27	3.34b \pm 2.37	1.45a \pm 0.74	1.37a \pm 0.70	1.46a \pm 0.75
	3	1.81c \pm 1.02	1.76b \pm 1.01	1.83c \pm 1.04	1.07a \pm 0.49	0.986a \pm 0.46	1.09a \pm 0.50
	4	4.94a \pm 2.29	4.56a \pm 2.18	4.98a \pm 2.29	1.40a \pm 0.68	1.34a \pm 0.62	1.42a \pm 0.67
	LSD	1.35	1.30	1.36	0.45	0.41	0.45
Autumn	1	0.268c \pm 0.12	0.237c \pm 0.03	0.279c \pm 0.12	0.162ab \pm 0.08	0.122b \pm 0.06	0.193ab \pm 0.07
	2	0.595b \pm 0.16	0.531b \pm 0.05	0.623b \pm 0.17	0.166ab \pm 0.06	0.151b \pm 0.05	0.178ab \pm 0.06
	3	0.515b \pm 0.14	0.462b \pm 0.03	0.555b \pm 0.16	0.128b \pm 0.03	0.109b \pm 0.01	0.141b \pm 0.02
	4	1.38a \pm 0.38	1.31a \pm 0.12	1.39a \pm 0.39	0.219a \pm 0.07	0.206a \pm 0.06	0.226a \pm 0.06
	LSD	0.17	0.17	0.18	0.05	0.04	0.05
Winter	1	0.094b \pm 0.03	0.076c \pm 0.02	0.103b \pm 0.03	0.049b \pm 0.01	0.042b \pm 0.01	0.054b \pm 0.01
	2	0.131b \pm 0.04	0.111b \pm 0.05	0.137b \pm 0.04	0.057b \pm 0.01	0.049ab \pm 0.01	0.059ab \pm 0.01
	3	0.106b \pm 0.04	0.092b \pm 0.04	0.113b \pm 0.05	0.051b \pm 0.01	0.043ab \pm 0.01	0.056ab \pm 0.01
	4	0.410a \pm 0.07	0.373a \pm 0.05	0.430a \pm 0.08	0.076a \pm 0.02	0.055a \pm 0.01	0.081a \pm 0.020
	LSD	0.04	0.03	0.04	0.015	0.010	0.019
Spring	1	0.081b \pm 0.03	0.069c \pm 0.03	0.085b \pm 0.03	0.044a \pm 0.011	0.038a \pm 0.011	0.047a \pm 0.012
	2	0.111b \pm 0.04	0.100b \pm 0.04	0.112b \pm 0.04	0.052a \pm 0.012	0.045a \pm 0.012	0.056a \pm 0.013
	3	0.099b \pm 0.04	0.092b \pm 0.03	0.103b \pm 0.04	0.045a \pm 0.013	0.041a \pm 0.013	0.049a \pm 0.011
	4	0.232a \pm 0.07	0.216a \pm 0.06	0.241a \pm 0.08	0.052a \pm 0.01	0.046a \pm 0.010	0.055a \pm 0.010
	LSD	0.04	0.03	0.04	0.012	0.02	0.01

Different column letters mean significant differences $P \leq 0.05$

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