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Cite as: AIP Conference Proceedings **2475**, 050002 (2023); https://doi.org/10.1063/5.0102905
Published Online: 31 March 2023

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Bioaccumulation Of Heavy Metals In Carp Fish (Cyprinus Carpio L.) Cultured In Earthen Ponds In Sites Of Basrah University

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Abstract. In this study concentration of heavy metals; Cadmium, Lead, Zinc and Ferrous (Cd, Pb, Zn and Fe) were studied in tissues (muscles, gills, gonads and liver) of cultured carp fish (Cyprinus carpio L.) of the earthen ponds belonged to Basra University. Two stations were selected, the first was for the ponds of Marine Sciences Center and the second one was for the ponds located in the Al-Hartha Station for Agricultural Research. The results showed that the iron element recorded the highest concentrations in all the studied tissues in rang (8.22-53.81 mg/kg), while the cadmium element showed very slight detected. The liver organ showed the highest levels of cadmium and lead (0.0047 and 0.186 mg/kg) respectively, while the gill organ showed the highest level for zinc and iron (5.73 and 53.81 mg/kg). All concentrations of the elements were within the permissible level.

Keywords. Heavy metals, Bioaccumulation, Earthen pond, Cyprinus carpio

INTRODUCTION

Many Asian countries and some European countries paid much attention to fish farming, common carp fish (Cyprinus carpio) were considered as significant species for aquaculture [1]. These fish were able to take advantage of the nutrients available from the aerobic decomposition of organic matter by the bioturbation in bottom sediments during feeding on benthic organisms. It could bear better the low density of oxygen and high density of Carbon dioxide dissolved in the water than any other Carp [2]. The daily growth of carp can be 2 to 4 percent of body weight. Carps can reach 0.6 to 1.0 kg body weight within one season in the poly cultural fish ponds of subtropical/tropical areas [3]. (C. carpio) belongs to the family Cyprinidae, which is considered the largest family of freshwater fish, it generally inhabits freshwater environments, especially ponds, lakes and rivers. In Iraq, the aquaculture depends on the availability of water, as well as, good soil and adequate sites. Moreover, there are public and private aquacultures, and these are widely distributed in the middle and southern parts of Iraq; common carp is became the most popular species for fresh water aquaculture in Iraq [4]. Fish had important role in several food chains and it is considered as an essential food resource because it is contained in high proteins, fats, amino acids, omega-3 fatty acids and vitamins in addition to vital minerals such as Cu, Zn, Ca and Fe [5].

The increased pollutants particularly heavy metals which have capable to bioaccumulate in fish tissues and subsequently lead to health deterioration for these fish and then it cause health dangers for humans through food chain [6]. Aquatic ecosystems suffered from water pollution with toxic heavy metals which came from the dispersal and disposal wastes generated from industrial, agricultural and urban activity and these contaminants described as critical hazards for environment [7].

The bioaccumulation in tissues resulted in cellular and tissue damage, subsequently, dysfunction of variety of fish organs. These damages depended on type of subjected organism, levels of contaminants, environmental

1st International & 4th Local Conference For Pure Science (ICPS-2021)
AIP Conf. Proc. 2475, 050002-1–050002-8; https://doi.org/10.1063/5.0102905
Published by AIP Publishing. 978-0-7354-4327-3/$30.00

conditions and exposure period [8]. Fish can be used a bioindicator for environmental pollution, this attributed to accumulated capable for these metals hundreds or thousands of times more than it has been got in water, long lifespan, easy to be sampled and easy to be obtained in large quantity [9].

Amount of previous studies intensive on the culture and growth of carp fish in the city of Basra [10,11], but there are few studies on the effects of environmental pollution on fish farmed in these areas. Therefore, the main objective of current study was to evaluate the concentrations of heavy metals (Pb, Cd, Fe, and Zn) in the water used in aquaculture as well as the elements presented in four different organs namely muscle, gills, liver and gonads of the common carp fish farmed in earthen ponds belonged to Basra University.

MATERIALS AND METHODS

- **Study Area**

Two stations were chosen for the earthen ponds, the first at the Marine Sciences Center (30.560993, 47.741800) and the second one for the Al-Hartha Station for Agricultural Researches (30.655779, 47.748134), according to the map shown in Figure (1), these stations were chosen because they are affiliated with the University of Basra and because they are important for scientific research, as well as have an economic benefit for marketing fish.

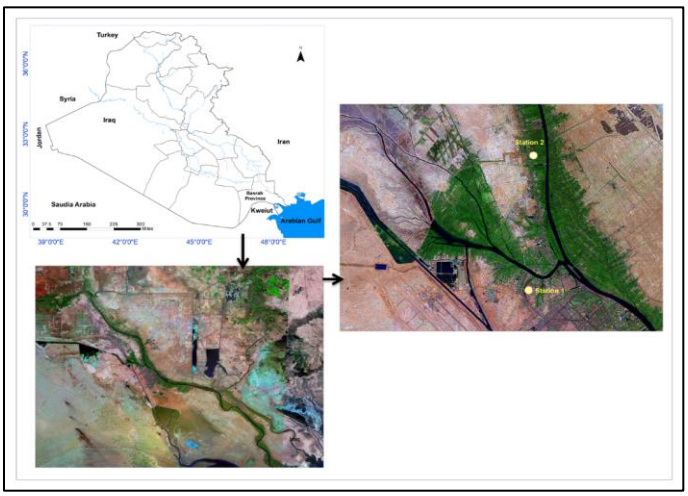

FIGURE 1. Map of study sites which located in Basrah Province.

Carp fish (Cyprinus carpio) were randomly selected (30 fish from each sampling site) which ranged from 23 to 26 cm in total length and reached between 215 to 250 g in weight. Deionized water was used to wash the fish and inserted into a waterproof plastic bag and directly labelled, then they were placed in a closed container containing ice packets and transferred to a laboratory on the same day and the samples were kept at a temperature -20°C.

Concerning the water test, samples were collected in 500 ml glass bottles, and drops of concentrated nitric acid were added for the purpose of fixing the samples and transferred directly to the laboratory of the Marine Sciences Center under refrigeration for performing analysis operations on it.

- **Fish sample preparation and analysis**

After the fish sample was de-frozen to room temperature, the fish were dissected with stainless steel knives, and, gills, muscles, gonads and liver were taken. Samples were washed with tap water and then with deionized water. They were then oven dried at 105 ° C overnight. Samples were crushed and 1gm was taken for muscle, gills, and gonads, while the liver was 0.1g dry weight.

Samples were subjected to four replicates. The samples were digested with 6 mL nitric acid (65%) and 1 ml hydrogen peroxide (35%) [12]. The solution was supplemented to 50 ml with deionized water for muscle, gill and gonad samples while liver samples were completed to 25 ml. The analysis was conducted by using (Atomic

Absorption Spectroscopy model GBC Savant AA Ver3.02). The assessment included concentrations of (Pb, Cd, Fe and Zn) in (mg/kg dry wt).

- **Water analysis**

The water samples (100 ml) were filtered using Millipore filter papers, then acidified with 6 ml of concentrated nitric acid and the solution was heated on a hot plate (without boiling) until maximum evaporated to reduce the solution to 10 ml, after which it was transformed into a 50 ml volumetric flask then the solution was supplemented to 50 ml with de-ionized water [13], and the final samples were measured by atomic absorption spectroscopy. All data were subjected to two-way analysis of variance (ANOVA) test under significant level ($P < 0.05$) by using SPSS program version 20.

RESULT AND DISCUSSION

The current study documented the occurrence of heavy metals (Pb, Cd, Zn and Fe) in the tissues of carp fish at the Marine Sciences Center station (Table, 1). Iron, which is one of the important elements, was recorded at the highest concentrations in all tissues (muscles, gills, liver, and gonads), while cadmium appeared to be the lowest concentration of elements in all tissues.

TABLE 1. Metals concentrations means in tissues (mg/kg) of Cyprinus carpio and in water samples (mg/l) from earthen ponds of Marine Science Centre

Sample	Cd	Pb	Zn	Fe
Carp Muscles	0	0.080333	0.433333	15.811
Carp Gills	0.000567	0.093	4.195333	15.10433
Carp Liver	0.0047	0.1865	3.1798	17.5585
Female Gonads	0	0	0.756	8.228
Permissible limit[1]	0.05 for fish muscle 0.5 for fish liver	0.3 for fish	< 5.00	--
Water	0	0	0.031	0.59
Permissible limit [2]	< 0.005	< 0.05	< 2.00	< 2.00

[1]Permissible limit by EC 2006

[2]Canadian environmental quality guidelines.

Cadmium element did not shown in the muscle tissue and gills but very little presence in the liver tissue was (0.0047 mg / kg) (Figure, 2). The current findings in agreement with many studies have proven that fish have the capacity to concentrate and accumulate heavy metals within their organs, especially the gills and [14,15]. Lead, which is a non-essential toxic element, was present in very small proportions less than the standard limits recorded in EC (2006) which was (0.3 mg/kg). Lead level in the muscle tissue was (0.08 mg / kg), nevertheless it did not record any concentration in fish gonads but cumulative concentrations in the liver tissue (0.186 mg / kg) (Figure, 3). Lead has an ability to accumulate in the liver and gills organs. This is concurring with the results of [16], on carp fish in artificial lake of Baghdad city, their findings showed the cadmium values in whole fish reached to the concentration (0.567mg / kg) and lead was (6.834mg / kg) in areas where close to industrial pollutants and their results indicated that the concentrations of cadmium and lead levels were higher than the permissible limits. Zinc element was recorded in normal concentrations and the highest concentration was in the tissues of gills, then the liver (4.19 and 3.17 mg / kg) (Fig., 4). Its appearance was due to its presence in the water used in fish culture, which was (0.031 mg / liter) (Fig., 6). This is consistent with the study result of [17], in muscles of common carp fish in the Iraqi rivers, whose reported that zing metal value ranged from (0.21- 100 mg/kg) in different geographical areas. Zinc is one of the essential elements to the organism and this metal considered Co-factors for many biological activities, but the increase in the concentration of this element becomes more hazardous and has negative effects on fish in terms of accumulation and affecting the enzymatic activity [18].

Regarding iron element, the highest concentrations were recorded, compared with other elements, in tissues (liver, gonads, gills and muscles) of carp fish cultured in the ponds of the Marine Sciences Center; it is one of the essential elements which involved in blood composition, recorded the highest value in liver tissue (17.55 mg / kg) (Fig., 5). The source of iron due to its presence in high concentrations in the cultured waters of the earthen ponds of the Marine Science Center, its concentration level was higher compared to the rest of the elements (0.59 mg / l) (Fig. 6). This was corresponded to study of [19], on vital organs (muscle, liver, gills, and kidney) of Wallago attu and Cyprinus carpio, they recorded the iron element was the highest level in the order of metals accumulation (Fe > Cr > Pb > Cu) in gills and muscle .

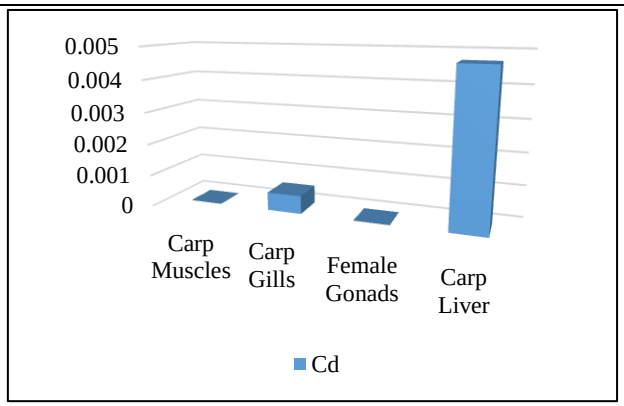

FIGURE 2. Concentrations of Cadmium metal (mg/kg) in *C. carpio* tissues at ponds of Marine Science Center

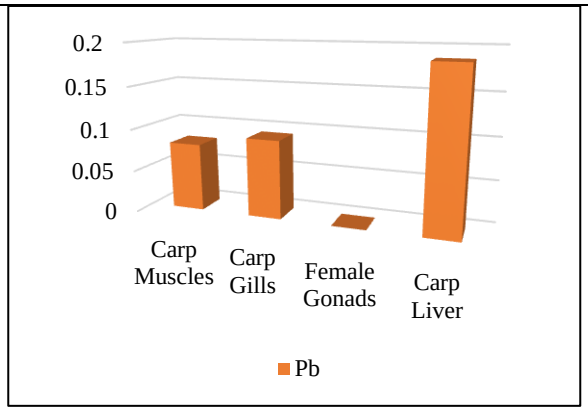

FIGURE 3. Concentrations of Lead metal (mg/kg) in *C. carpio* tissues at ponds of Marine Science Center

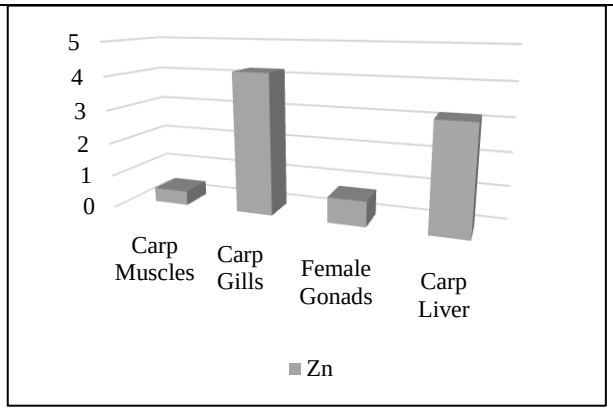

FIGURE 4. Concentrations of Zinc metal (mg/kg) in *C. carpio* tissues at ponds of Marine Science Center

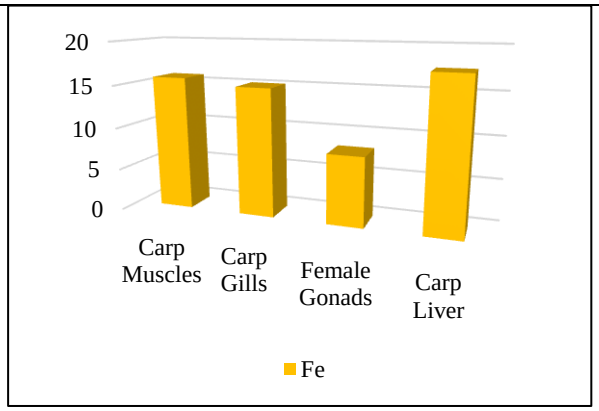

FIGURE 5. Concentrations of Iron metal (mg/kg) in *C. carpio* tissues at ponds of Marine Science Center

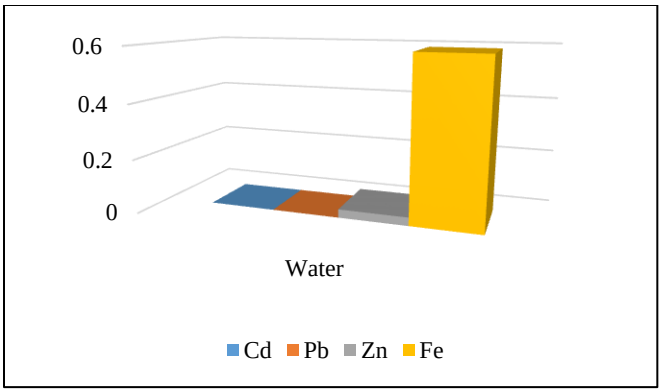

FIGURE 6. Concentrations of metals (Cd, Pb, Zn and Fe mg/l) in ponds water of Marine Science Center.

In the second station, Al-Hartha Station for Agricultural Research, the iron element was recorded in the highest concentrations in all tissues, while the cadmium element was not detected in the tissues of carp fish (Table, 2 and Fig., 8). This was due to the absence of cadmium ions in the water samples used in the earthen ponds for fish farming in the second station (Fig. 7). While the lead element was recorded fluctuating concentrations among the tissues of carp fish, however, the highest level was verified in the liver tissue (0.186 mg / kg) and the lowest concentration was recorded in the gonads (0.013 mg / kg) (Table, 2 and Fig., 8).

TABLE 2. Metals concentrations means (mg/kg) in tissues of Cyprinus carpio and in water samples (mg/l) from earthen ponds of Al-Hartha station for agricultural researches.

Sample	Cd	Pb	Zn	Fe
Carp Muscles	0	0.015567	0.498333	8.936667
Carp Gills	0	0.037	5.736	53.818
Carp Liver	0	0.186	1.239	5.944
Carp Gonads	0	0.013	0.5455	4.37
Water	0	0.202333	0.223367	3.188333

Liver are main responsible for the chemical processes of metabolism. Moreover, it is the main structure of biotransformation, accumulation, and elimination of foreign substances [19]. All the values of lead concentrations within the permissible level (< 0.3 mg/kg) [20]. One of the sources of lead metal accumulation in the gill tissues was from the source of surrounding water used aquaculture of living fish, and then it was spread through the circulatory system to the tissues of the liver, muscles and gonads, where the concentration level of lead ions in the water of the second station was recorded (0.202 mg/l) (Table, 2) which was higher than the permissible limit (0.05 mg/l) mentioned in Canadian environmental quality guidelines [21]. And thus led to the existence and accumulation of this element in the tissues of studied fish.

The zinc element showed accumulation in all tissues of the studied fish and at a different levels among tissues, the highest level was in gill tissues, followed by liver, muscles and gonads (Fig., 9). The presence of zinc here was normal and below the permissible level. As for the gills, which had the highest accumulated concentration (5.73 mg / kg), this indicates that the fish received this element from the aqueous medium containing a good concentration of zinc ions (0.22 mg/l) (Table, 2). As for iron, it is also one of the essential elements that the organism needs, as it recorded the highest concentrations compared to other elements, and the highest level was in the tissues of gills also (53.818 mg / kg) (Table, 2), followed by muscle, liver and gonad tissues (Figure, 10). Fish gills carry out absolutely necessary functions such as the action of breathing, osmoregulation, acid–base balance in addition to nitrogenous waste expulsion [22]. The gills are the sensitive organ to be affected by environmental pollutants; subsequently, gill tissues were recorded the highest accumulation of zinc and iron, for that reason, they are often used in the assessment of freshwater habitats exposed to different pollutants. Previous studies have shown that fish gills affected short-term and long-term also for individual metal exposure [23,24].

Conclusion: The current study concluded that the studied heavy metals in the tissues of carp fish for muscles, gills, liver and gonads were within the permissible level. The liver organ had the highest cumulative level for cadmium and lead concentrations, while the gill organ showed the highest levels were for zinc and iron elements.

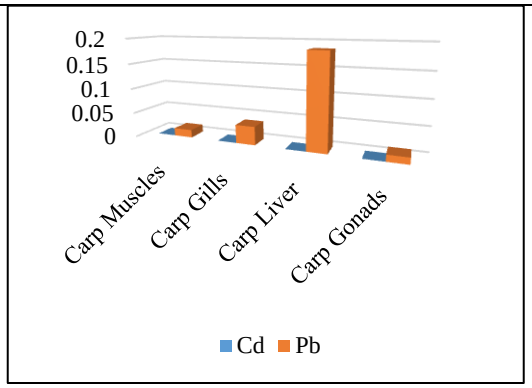

FIGURE 7. Concentrations of metals (Cd, Pb, Zn and Fe mg/l) in ponds water of Al-Hartha Station for Agricultural research

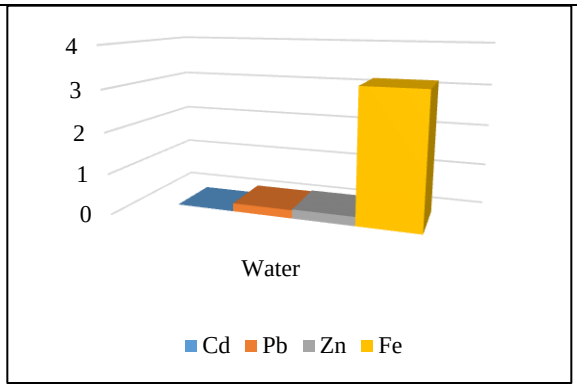

FIGURE 8. Concentrations of metals (Cd and Pb, mg/kg) in *C. carpio* of Al-Hartha Station for Agricultural research

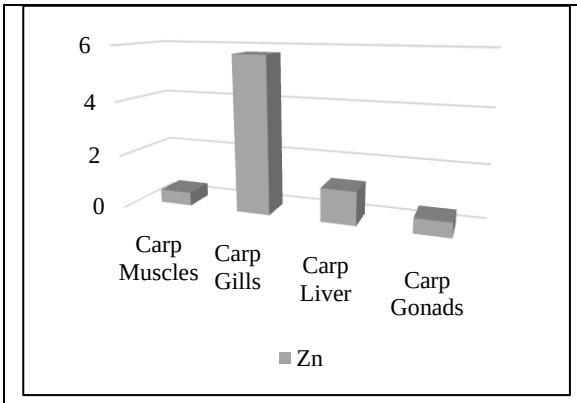

FIGURE 9. Concentrations of zinc metal (mg/kg) in tissues of *C. carpio* at Al-Hartha Station for Agricultural research

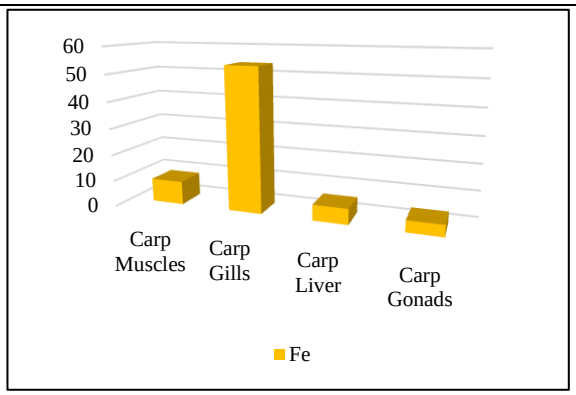

FIGURE 10. Concentrations of Iron metal (mg/kg) in tissues of *C. carpio* at Al-Hartha Station for Agricultural research

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