Study seasonal changes in concentration of some heavy metals in *Carasobarbus luteus* of southern Iraq marshes

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Abstract

The concentration of heavy metals (cadmium, cobalt , copper , iron , nickel and manganese was measured in the muscles of the *Carasobarbus luteus* using a flame atomic absorption spectrophotometer. The average length of fish samples was (198.7) mm, and the average weight of fish samples was (105.31) gm. The results showed the highest average of concentration metals (cadmium, cobalt, copper, and iron) were (19.59, 25.05, 17.52, and 72.37) µg/g (dry weight), respectively, in the Eastern Al-Hammar marsh, whereas the highest average of concentration metals (nickel, and manganese) were (59.24, and 11.08) µg/g (dry weight), respectively, in the Al-Hawizeh marsh during the study period.

Keywords: Bioaccumulation, Fish, Heavy metals, Marsh, Iraq.

دراسة التغيرات الفصلية في تركيز بعض العناصر الثقيلة في عضلات أسماك ألحمري في أهوار جنوب العراق

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الخلاصة

تم قياس تركيز المعادن الثقيلة (الكادميوم ,الكوبالت ,النحاس ,الحديد ,النيكل والمنغنيز) في عضلات أسماك ألحمري *Carasobarbus luteus* باستخدام مقياس طيف الامتصاص الذري اللهبي (Flame Atomic Absorption Spectrophotometer). بلغ معدل طول عينات الاسماك (198.7) ملم ومعدل وزن هذه العينات (105.31) غرام. أظهرت النتـائج آن أعلى معدل تركيز المعادن (الكادميوم، الكوبالت، النحاس، الحديد) خلال فترة الدراسة كانت (19.59، 25.05، 17.52، 72.37) مايكروغرام/غرام (وزن جاف) على التوالي في هور الحمار الشرقي , في حين بلغ أعلى معدل تركيز المعادن (النيكل والمنغنيز) (59.24 ,11.08) مايكرو غرام/غرام (وزن جاف) في هور الحويزة على التوالي .

الكلمات المفتاحية : التراكم الحيوي، الاسماك، العناصر الثقيلة، الاهوار، العراق.

1. Introduction

Term ‘heavy metals’ are defined as heavy metals either due to their high atomic weight or because of their high density. Nowadays, the word ‘heavy metal’ has been used to describe metallic chemical elements and metalloids which are toxic to the environment and humans. Some metalloids and also lighter metals such as selenium, arsenic and aluminum are toxic. They have been termed heavy metals while some heavy metals are typically not toxic such as the element gold (Wang 2009; Tchounwou, et al., 2012; Lenntech, 2018). Heavy metal pollution has emerged due to anthropogenic activity which is the prime cause of pollution, primarily due to mining the metal, smelting, foundries, and other industries that are metal-based, leaching of metals from different sources such as landfills, waste dumps, excretion, livestock and chicken manure, runoffs, automobiles and roadworks. Heavy metal use in the agricultural field has been the secondary source of heavy metal pollution, such as the use of pesticides, insecticides, fertilizers. Natural causes can also increase heavy metal pollution such as volcanic activity, metal corrosion, metal evaporation from soil and water and sediment re-suspension, soil erosion, geological weathering (He, et al., 2005; Walker, et al., 2012 and Masindi, et al., 2018).

After being released from the earth's crust, heavy metals persist in the environment for a long time because they are non-degradable (Wu, et al., 2010). Because heavy metals exert toxic effects on microorganisms, plants, animals, and humans, their contamination in the environment has become one of the biggest environmental issues of the present time and is of even greater concern for the future. Several heavy metals, including iron (Fe), cobalt (Co), copper (Cu), manganese (Mn), and zinc (Zn), are crucial for the metabolic activity of biota at low concentrations and are considered essential elements or micronutrients (Peralta-Videa, et al., 2009). But when heavy metals concentration exceeds a certain threshold, they produce adverse effects (Ali, et al., 2013; Geist and Hawkins, 2016).

Heavy metals enter the aquatic environment from both anthropogenic and natural sources (Ghorab, 2018) where they are partitioned throughout various aquatic environmental compartments (water, suspended solids, sediments, and biota) and can lead to deleterious effects which may be acutely or chronically toxic to aquatic life within the affected area.

Living organisms can absorb dissolved heavy metals in the aquatic environment through some tissues in the body, such as the gills and skin, and concentrate them in the liver, kidneys, gonads, and muscles, which leads to their accumulation in high concentrations in the body (Flessas, et al., 1993). Another group of heavy metals that are non-essential and have no biological importance, such as (cadmium, mercury, lead, and arsenic) are considered dangerous even if they are found in low concentrations in the environment, whereas increased concentrations lead to poisoning and death (Park and Presley, 1997). As well as, Acacia, et al., (2006) confirmed that the level of the toxic effect of these metals depends on the type of element and its concentration in the aquatic environment, as well as the time of exposure to this element.

Many local studies have been conducted to determination of heavy metals in fish freshwater, including (Khafaji, et al., 1997, *Liza subviridis* and *Nematolsa nasus*; Al-Khafaji, et al., 2011, C. *carpio*; Al-Khafaji and Lazim, 2013, *C.carpio* and *Carasobarbus luteus;* Aldoghachi, et al., 2016, *Oreochromis sp*. Farhood and Ali, 2020, *C.carpio;* Mustafa, et al., 2020, *C. luteus* and *C. carpio;* Alkshab and Fathi, 2021, *G. affinis;* Al-Enazi and Lazim, 2023, *Liza abu*, *Mesopotamichthys sharpeyi* and *C. luteus;* Aldoghachi and Alabdul, Aziz 2023, *C. carpio;* Al-Niemi and Al-Kshab ,2023 , *Alburnus mossulensis;* Kaizal, et al., 2023**,** *Oreochromis aureus* and *Leuciscus vorax;* Nasser and Fahad, 2023, *Ctenopharyngodon idella*.

This work conducted to measure seasonal and locational changes to know the concentrations of heavy metals accumulated in muscles of fish *Carasobarbus luteus* species, which are considered of economic fish and the extent their impacts on human health when eats in his food.

2. Material and methods

2.1 The study area

Al-Hawizeh marsh is mostly located in Maysan Governorate and extends from the Al-Mushrah district in Maysan of the south to the city of Al-Qurna in Basra Governorate in the east, and from the Iraqi-Iranian border in the east to the east of the Tigris River in the west, it extends between (**31° 32' 19.19" N, 47° 42' 14.39" E**). The area is distributed by 79% for the Iraqi part and by 21% for the Iranian part (Domad, 2008). Its length is about 80 km, from the Iraqi-Iranian borders to the east of the Tigris River from its western part, with wide of 30km (Abbas, 2006). The Hammar Marshes are located in the Dhi Qar and Basra Governorates. They are bordered in the north by the city of Al-Qurnah, in the northeast by the Euphrates River, in the southeast by the city of Basra, in the south by saline lakes and the Arabian Desert, in the west and northwest by the urban centers of Nasiriyah and Al-Chibayish. Its main water sources are the Euphrates and its tributaries. It extends between (**30° 45' 59.99" N, 47° 02' 60.00" E**) Additional water from the Tigris reached the wetland through overflow from the Central Marshes.

Monthly samples (210, 319) of fish *C. luteus* captured from the Al-Hammar and Al-Hawizeh marshes, respectively. The fish lengths and weights were recorded, with an average length of (198.7) mm and an average weight of (105.31) g. The ROPME (1982) method was applied for the digestion of fish muscles and estimation of trace metal content. where preparation, 0.5 g of dried and ground samples and placed in glass tubes.

A mixture of perchloric acid ($HClO_4$) and concentrated nitric acid (HNO_3) in a 1:1 ratio (3 ml) was added. The tubes were placed in a water bath at 70 °C for 30 minutes and transferred to a heating plate for complete digestion until clarified the mixture. Undigested parts (fibers) of samples were filtration using a centrifuge, the filtrate solution was collected, its volume adjusted to 25 ml with deionized distilled water. The filtrate solution was stored in tightly sealed plastic bottles until examination with a flame atomic absorption spectrometer, and yield was expressed in µg/g dry weight.

Statistical analysis of the results was conducted using the SPSS program, and differences between means were assessed using the Revised Least Significant Difference (RLSD) test at a significance level of 0.05, following the explanation provided by Al-Rawi and Khalaf Allah (2000).

3. Results

Table (1) shows the environmental factors were measured throughout the study period. In the East Al-Hammar marsh site, the results achieved the highest pH value of 8.7, contrasting with its lowest value of 7.30 in the summer season. Whereas in the Al-Hawizeh marsh, the pH values are between 7.05 and 8.15 during the spring and winter, respectively. Salinity peaked at 3.82‰ in the summer, whereas it decreased to 2.20‰ in the winter at the East Al-Hammar marsh. Furthermore, in Al-Hawizeh marsh, the highest salinity value was 0.80‰ in the summer, while the lowest value was 0.55‰ in the winter. In addition, the dissolved oxygen (DO) levels varied from 8.27 mg/L to 10.60 mg/L during the summer and winter, respectively, in the East Al-Hammar marsh. In contrast, the (DO)value ranged between 9.10 mg/L and 10.85 mg/L during summer and winter, respectively. On the other hand, the highest water temperature was 29.2°C in East Al-

Hammar marsh during the summer, while the lowest value was 12.70°C during the winter. In contrast, the highest water temperature was 28 ºC in summer and the lowest value 12.2 ºC in the winter at Al-Hawizeh marsh.

Table (1): Environmental factors during the study period in the East Al-Hammar and Al-Hawizeh marshes southern of Iraq

Stations	Season	Water temperature ºC	Dissolved oxygen mg/L	Salinity %	pH
East Al-Hammar	Autumn	14.30	9.90	2.29	8.20
	Winter	12.70	10.60	2.20	8.70
	Spring	20.90	10.50	3.14	7.40
	Summer	29.20	8.27	3.82	7.30
Al- Hawizeh	Autumn	14.10	10.40	0.70	8.10
	Winter	12.20	10.85	0.55	8.15
	Spring	20.30	10.60	0.70	7.05
	Summer	28.00	9.10	0.80	7.70

Table (2) shows the average seasonal and locational cadmium concentration (µg/g dry weight) in the muscles of the *C. luteus* fish during the present study. The findings showed clear variations between the averages with a probability of ($P>0.05$). The highest concentration of cadmium was achieved during the autumn, reaching 19.59 µg/g dry weight in the Eastern Al-Hammar marsh, and the lowest value occurred in the winter at 1.161 µg/g (dry weight) in the same location. Whereas in Al-Hawizeh marsh the highest concentration of cadmium was 16.20 µg/g dry weight in the spring, the lowest value occurred in the winter at 1.74 µg/g (dry weight) in the same site. Statistical analysis revealed significant differences at a significance level of $p<0.05$ among the sites, which showed East Al-Hammar marsh as superior morally compared to Al-Hawizeh marsh.

Table (2): Seasonal and locational averages of cadmium concentration (µg/g dry weight) in muscles of fish *C. luteus*

Stations		Summer	Spring	Winter	Autumn
East Al-Hammar	Average	6.17	10.80	1.16	19.59
	Standard deviation	2.63	2.08	0.14	1.22
Al-Hawizeh	Average	9.26	16.20	1.74	4.90
	Standard deviation	1.09	1.73	0.86	1.03
	LSD value	2.60			

The results in Table 3 indicate there is a significant difference between the seasonal and locational averages for cobalt concentration at probability (P>0.05) in the muscles of *C. luteus* fish. The highest value of cobalt in *C. luteus* was 25.05 µg/g dry weight achieved during the winter; in the East Al-Hammar marsh, and the lowest value was below the sensitivity level of the atomic absorption spectrometer in the autumn. Whereas in Al-Hawizeh marsh, the highest value of cobalt in *C. luteus* achieved 18.46 µg/g dry weight during the summer, and the lowest value was below the sensitivity level of the atomic absorption spectrometer in the winter. The statistical results revealed significant differences (p<0.05) between the sites, which showed the East Al-Hammar marsh as superior morally compared to the Al-Hawizeh marsh.

Table (3): Seasonal and locational averages of cobalt concentration (µg/g dry weight) in muscles of fish *C. luteus*

Stations		Summer	Spring	Winter	Autumn
East Al-Hammar	Average	7.39	11.08	25.05	ND
	Standard deviation	1.34	0.76	1.24	ND
Al- Hawizeh	Average	18.46	11.08	ND	14.59
	Standard deviation	1.47	1.73	ND	1.25
	LSD value	3.61			

The current study showed a significant variation in the seasonal and locational averages of copper concentration (µg/g dry weight) in the muscles of the studied fish. The highest concentration of copper in the muscles of *C. luteus* was 17.52 µg/g dry weight during the summer in the Eastern Al-Hammar marsh, while the value decreased during the winter to the level that was non-detected (ND) by the atomic absorption spectrometer in the East Al-Hammar and Al-Hawizeh marshes, respectively. In contrast, the highest concentration of copper in *C. luteus* was found at 14.34 µg/g dry weight during the spring, as shown in Table (4). The statistical results observed significant differences ($p<0.05$), as the Al-Hawizeh marsh showed moral superiority compared to the East Al-Hammar marsh.

Table (4): Seasonal and locational averages of copper concentration (µg/g dry weight) in muscles of fish *C. luteus*

Stations		Summer	Spring	Winter	Autumn
East Al-Hammar	Average	17.52	9.56	ND	1.99
	Standard deviation	2.17	0.16	ND	0.15
Al- Hawizeh	Average	7.97	14.34	ND	4.12
	Standard deviation	1.07	0.98	ND	0.83
	LSD value	2.07			

In the results registered for other metals in the muscles of fish *C.luteus* there is a significant variation in the seasonal and locational averages of iron (µg/g dry weight) of the studied fish samples, the highest iron concentration was 72.37 µg/g dry weight during the winter, while the lowest average concentration of this metal was 36.05 µg/g dry weight during both summer and spring in the East Al-Hammar marsh. In contrast, the highest average concentration of iron in fish muscles, *C. luteus* achieved 31.01 µg/g dry weight during the winter, while the lowest value concentration of this metal was 18.03 µg/g dry weight during the spring (Table 5). The statistical analysis showed significant differences between the studied sites at the $p<0.05$ level, as Al-Hawizeh marsh showed a significant superiority compared to East Al-Hammar marsh.

Table (5): Seasonal and locational averages of iron concentration (µg/g dry weight) in muscles of fish *C. luteus*

Stations		Summer	Spring	Winter	Autumn
East Al-Hammar	Average	36.05	36.05	72.37	37.15
	Standard deviation	1.71	1.05	1.86	1.72
Al- Hawizeh	Average	27.04	18.03	31.01	31.01
	Standard deviation	1.71	1.69	0.37	1.73
		6.22			

Table (6) shows a significant variation between the seasonal and locational average concentration of nickel (µg/g dry weight) in the muscles of the studied fish samples. Therefore, the highest concentration of nickel in fish *C. luteus* reached 44.85 µg/g dry weight during the autumn, and the lowest value achieved 18.22 µg/g dry weight during the spring in the East Al-Hammar marsh. Furthermore, the results of the test of this metal were varied in Al-Hawizeh marsh, where the highest concentration of nickel in fish *C. luteus* was 59.24 µg/g dry weight during both the winter and autumn seasons, and the lowest value reached 16.33 µg/g dry weight in the spring. The statistical results showed significant differences at the $p<0.05$ level between the two sites, where the Al-Hawizeh marsh had a significant superiority compared to the East Al-Hammar marsh.

Table (6): Seasonal and locational averages of nickel concentration (µg/g dry weight) in muscles of fish *C. luteus*

Stations		Summer	Spring	Winter	Autumn
East Al-Hammar	Average	22.24	18.22	33.86	44.85
	Standard deviation	1.76	3.11	4.90	4.00
Al- Hawizeh	Average	18.36	16.33	59.24	59.24
	Standard deviation	2.00	2.00	4.00	2.00
		5.45			

Furthermore, the results reported significant differences between the seasonal and locational averages of manganese concentration (µg/g dry weight) in the muscles of the fish *C. luteus*. Where recorded, the highest value of 5.54 µg/g dry weight was during the winter in East Al-Hammar marsh, while the lowest value of 3.82 µg/g dry weight was recorded during the summer in the same site (Table 7). On the other hand, the highest value concentration of this metal was 11.08 µg/g dry weight during the spring, while the lowest value was 1.99 µg/g dry weight during the winter in the Al-Hawizeh marsh. The results of the statistical analysis revealed that there were significant differences at the $p<0.05$ level between the two studied sites, therefore, Al-Hawizeh marsh noted a significant superiority compared to East Al-Hammar

Table (7): Seasonal and locational averages of manganese concentration (µg/g dry weight) in muscles of fish *C. luteus*

Stations		**Summer**	**Spring**	**Winter**	**Autumn**
East Al-Hammar	Average	3.82	4.78	5.54	3.98
	Standard deviation	0.92	0.97	0.48	0.14
Al- Hawizeh	Average	3.18	11.08	1.99	3.98
	Standard deviation	1.10	1.09	0.01	0.51
		1.81			

4. Discussion

The characteristics of water in different bodies are affected by several environmental factors that may be physical, such as climate or geology, as well as the vegetation present in the water body. (Wetzel, 2001). Temperature influences physical factors, which depend on seasonal and locational changes. They are essential in terms of their impact on water bodies, characteristics, salinity, dissolved oxygen, electrical conductivity, etc. (Smith, 2000). The pH values showed a slight variation between the different seasons and between the two chosen study sites, where the highest rate was recorded during the winter as alkaline water. In general, Iraqi water is classified as low-alkaline water. Regarding seasonal change, winter was characterized by increased pH values, which may affect aquatic plants, whereas phytoplankton played a role in their decrease in high photosynthesis rates and, thus, an increase in the consumption of carbon dioxide (CO_2).

These results were consistent with what was indicated by (Richardson and Hussein, 2006). The waters of the Al-Hawizeh marsh are generally less salty than the eastern Al-Hammar marsh because they receive water from the Iranian rivers and the Tigris River, Unlike the East Al-Hammar marsh, which takes its water from the Euphrates River only. The salinity of the water of East Al-Hammar marsh is higher in all seasons than in the water in Al-Hawizeh marsh. Dissolved oxygen plays a vital role in the metabolic processes of all living organisms (Wetzel, 2001), and its source is in water bodies. Plankton and aquatic plants have a role in supplying the water body with it through photosynthesis (Wetzel and Likens, 2000). The results showed a noticeable increase in the dissolved oxygen content in the studied areas. This increase may be the result of good ventilation and continuous mixing, as well as the significant role of aquatic plants, in addition to the fact that they are wide open spaces in which the process of gaseous exchange is facilitated, the highest concentration was recorded in the Al-Hawizeh marshes during the winter. while the lowest concentration was recorded in eastern Al-Hammar marsh during the summer. The dissolved oxygen (DO) level decreases due to the direct effect of temperatures and their consumption in the organic decomposition of accumulated materials (Saad, 1976).

Most aquatic organisms including fish, can accumulate heavy metals within their bodies at concentrations higher than in the aquatic environment (Park and Presley, 1997). The results of the study in Table (2) showed a decrease in the values of the element cadmium extracted from the muscles of the studied samples. During the study seasons, the values were low and fluctuated, and they observed an increase in the concentration of this cadmium element during the autumn and spring seasons. The results agreed with the study of Joyeux, et al., (2004) on *Mugil spp*. and *Centropomus spp*. caught from the Gulf of Vitria in Brazil. It was found that the concentration of cadmium during the spring and autumn seasons is higher than in the winter and summer, which may be because the growth of fish stops during the winter and spring seasons.

During these seasons, there is an increase in the metabolic activities of the organism and, thus, an increase in growth until it reaches its peak during the summer, and the cadmium element recorded a higher concentration than it was previously recorded. In the study, Al-Khafaji, (1996) measured the concentration of trace metals in common carp fish *C. carpio* and the patient fish *T. ilisha*, as it was found that the concentration varies depending on the species of fish, and the reason for this may be attributed to the difference in the ability of fish to regulate the level of elements within their bodies through the process of feeding and excreting waste, while the cadmium metal in this study recorded a slight increase from concentrations recorded by Al-Saad , et al. , (2008) in a study on *T. ilisha* fish, which was captured from the Shatt al-Arab and the Arabian Gulf. As for the concentration of cobalt in fish muscles, the results showed a clear fluctuation in the values of the cobalt element, showing a difference in concentration from imperceptible values to slight increases in muscle tissue, where the highest concentration occurred during the winter.

The results of this study were similar to the findings of Al-Saad, et al.,(1997) in their study on five species of fish caught from the Shatt al-Arab and the Arabian Gulf, where they found varying concentrations of cobalt extracted from muscles depending on the species studied. The concentrations measured in the current study were low and acceptable for human consumption.

The results indicated that the concentration of copper in the studied fish increased during the spring and summer seasons, as it is known that *C. luteus* are mixed-feeders, naturally, and they feed on some species of algae that have high concentrations of copper. This element is important because it is included in the chemical composition of the respiratory pigment of soft creatures and invertebrates (Bryan, 1968). In this study, the copper metal was recorded at lower concentrations than the concentrations recorded by Al-Saad, et al., (2008) in their study on *T. elisha* fish caught from the Shatt Al-Arab River and the Arabian Gulf. The decrease of the copper metal in fish muscles may be due to the amount of calcium carbonate in the water because Iraqi soil contains this substance. It dissolves in water; thus, the water is rich (Hassan, 2007), while the copper element in this study recorded a noticeable decrease.

They also noticed an increase in the concentrations of iron extracted from fish tissue in the two sites, as iron is one of the essential metals that constantly has high muscle concentrations, as its highest values were recorded during the winter. At the same time, the current results were higher than what was recorded by Al-Khfaji, et al.,(1997) in their study on the *Liza carinata*, while Abaychi and Al-Saad, (1988), in their study on fish caught from the Shatt Al-Arab River and the Arabian Gulf, recorded an increase in the concentration of iron and a decrease in the concentration of manganese, and the reason for this increase may be due to During the winter season, rainfall increases and thus washes the nearby soil, carrying some heavy metals into the aquatic environment. The increase of this element in the environment may be due to the remnants of war and the quantities of metal used in building boat hulls in the region. As well as, the increase in the concentration of nickel extracted from the tissues of *C.luteus* during the autumn and winter seasons, this is attributed to the nature of their nutrition and the amount of fat inside their bodies. This may be because nickel is high in phytoplankton and zooplankton during the spring and summer (Ni, et al., 2000).

The results showed a clear decrease in the concentration of manganese extracted from the fish tissues used during the study period, as the values were low and fluctuated, these results were consistent with the findings of Abaychi and Al-Saad, (1988) in their study on fish captured from the Shatt A-Arab River and the Arabian Gulf, where they found a decrease in the concentration of manganese in fish muscles compared to the concentration of other measured trace elements in a study by Edwin, (2007), it showed that the accumulation of manganese in benthic fish is higher than in fish that feed in the water column or at the surface.

The results generally showed slight locational and seasonal changes during the study period. However, the marshes are not polluted with this element because the low concentrations may be caused by the quantities of toxins and pesticides used in the fishing area, in addition to the quantities of agricultural fertilizers leaking from nearby agricultural areas that contain this element. Lakes close to agricultural lands cause increased concentrations of elements in river fish.

Furthermore, the study showed low and fluctuating cadmium, cobalt, copper, nickel, and manganese concentrations in fish muscles. Their levels varied between the regions studied, while the iron element recorded a noticeable increase between those regions. When comparing the values in this study with other studies, as the results of the current study demonstrated, the concentration of heavy metals in the fish of the Al-Hawizeh marsh and East Al-Hammar marsh is within the levels recorded in the region. The study demonstrated the presence of seasonal and locational variation in the concentrations of heavy metals in the fish-studied samples.

Excessive levels of heavy metals cause significant damage to every organ of the body and can display neurological defects, respiratory disorders, carcinogenicity, GI obstruction, osteoporosis, etc. (Mitra et al., 2021a). Heavy metals such as aluminum, cadmium, arsenic, mercury, lead, and chromium, these and other heavy metals are recognized systemic toxicants that are associated with several human health disorders, including chronic diseases such as cardiovascular diseases, neurological disorders, renal, lung, and dermal diseases, and various types of cancer (Mitra et al. 2022), whereas, deficiency in some of the trace elements in the body can lead to several neurodegenerative diseases characterized by progressive and irreversible damage to the brain. Trace element deficiencies that are largely due to improper eating habits and diseases associated with them can sometimes cause serious public health problems that lead to mass responses.

However, the degree of metal toxicity depends on various factors, including the valence state, the oxidation/reduction capacity of a metal ion, its solubility, the ionic radius of the metal, lipophilicity/hydrophilicity, its ability to interact with the ligand environment, and other structural characteristics.

5. Conclusions

1. Decrease and fluctuation of cadmium, cobalt, copper, nickel, and manganese concentrations in fish muscles.
2. This study showed there is a high concentration of iron in muscles fish *Carasobarbus luteus.*
3. Heavy metals in muscles fish of Al-Hawizeh marsh recorded a higher concentration than those fish of Al-Hammar marsh.
4. Presence of locational and seasonal variations in the concentration of metals.
5. Decreased quantities of water that entry to marshes, especially in summer season, that cause the increase in concentrations of metals in water.
6. Prevent the flow and entry of water polluted with waste water that carries within heavy metals resulting from factories and plants that discharge their water into the rivers feeding the marsh areas and the necessity of treating the water discharged from these activities before it reaches the rivers that feed marshes.
7. Not allowing the dumping of waste resulting from mining operations into rivers and stop the discharge water from (factories and plants) that carry with pollutants harmed the marsh environment and cause death of fish and other organisms in marsh areas, as well as imposing strict legal measures on violators and urging them to adhere to the instructions issued by government agencies.
8. The concentration of the studied elements was within internationally permissible limits, but it present in larger amounts can cause significant damage to every organ of the body and can display neurological defects, respiratory disorders, carcinogenicity, GIobstruction, osteoporosis also can damage the functioning of the brain, lungs, kidney, liver, blood

composition and other important organs, whereas, it deficiency in the body can lead to several neurodegenerative diseases characterized by progressive and irreversible damage to the brain.

6. Recommendations

1. Study the concentration of heavy metals in the primary and secondary nutritional levels for other economic fish species that are considered the main food for humans.
2. Monitoring for water quality in Al-Hawizeh and Al-Hammar marshes continuously to detect any negative impacts that may occur and finding a suitable solutions to conserve it from pollution, in order to conserve and protect biodiversity in marshes.
3. Develop a national and regional strategy to water source protection and working to ensure adequate water supply to Iraqi marshes in cooperation and application the agreements with neighboring countries.
4. Conservation of biodiversity in Al-Hawizeh marsh through the development of irrigation projects to enhance the increasing amount of water that enter to marshes, activating the role of institutions which concerned with the environment by increasing the environmental awareness of the Iraqi society.
5. Conducting an annual examination of fish samples randomly selected from the marshes to measure the concentration of heavy metals in the muscles, gills and liver of these samples.
6. Suggest some laws which ensure the protection the aquatic life and maintain it in marshes area, like arrangement of fishing season.

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