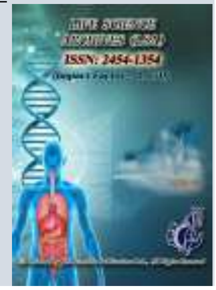
Available online at www.jpsscientificpublications.com

Life Science Archives (LSA)

ISSN: 2454-1354

Volume – 8; Issue - 6; Year – 2022; Page: 2517 – 2528

DOI: 10.22192/lsa.2022.8.6.1



Research Article

ESTIMATION OF POLLUTION BY SOME HEAVY METALS IN MUSCLES OF *Carassius auratus* (L.) FISH COLLECTED FROM THE EUPHRATES RIVER, CENTRAL IRAQ

Abbas Taleb Khleif[1], Sadiq Sahib Mohammed[2] and Dhurgham A.A. Al-Sultany[3]

[1]*Al-Qasim Green University, College of Environmental Science, Department of Pollution, Iraq*

[2]*Directorate of Education Dhi-Qar, Iraq*

[3]*AL-Qasim Green University, Collage of Science, Babylon, Iraq.*

Abstract

The study involved measuring the concentration of seven trace elements (Cadmium, Lead, Zinc, Iron, Manganese, Selenium and Nickel) in edible tissues of three classes of different weight and height of *Carassius auratus* (L.) collected from three sites of the Euphrates River, which were Al- Hindiya barrage (first site), Touirij (second location), and the Kifil (third site), for the period from Spring 2015 to Winter 2016. The study also estimated the concentrations of the trace elements studied in river water, in both dissolved and particular forms, as well as examined some physio-chemical properties of river water, whose variations depended on the different sites and seasons. The results of the present study indicated seasonal changes in the concentration of trace elements studied in both water forms (dissolved and particular form) and in fish muscle in the three locations of the current study. They noticed that the level of trace elements in the third group, the contrast between the first and second categories, was strong, and they found a clear link between the length and weight of the fish and the concentration of the fish, as elements of concentration increase with increasing length and weight. The results founded that the concentrations of trace elements studied in particular form were higher compared to dissolved form as well as the effectiveness of certain physical and chemical properties of water such as temperature, pH, electrical conductivity, and salinity on the concentration of these trace elements.

Article History

Received : 10.09.2022

Revised : 13.10.2022

Accepted : 17.11.2022

Key words: Trace elements, *Carassius auratus* (Linnaeus), Dissolved form, Particular form and, Physical and Chemical properties.

1. Introduction

The general problem is environmental pollution and the most important pollutants in the aquatic network are heavy metals due to their toxicity, accumulation and biomagnification by marine creatures. Industrial, domestic, agricultural and human activity activities can typically become the source of pollution of heavy metals by natural aquatic systems (Velez and Montoro, 1998; Conacher and Mes, 1993). Pollution caused by heavy metals may have dreadful effects on the ecological equilibrium of heavy metal pollution and a number of aquatic entities (Akinmoladun *et al*., 2007; Vosylien and Jankait, 2006).

In the food chain, toxins such as heavy metals bioaccumulate and cause adverse effects, even death, so fish are used to assess the health

***Corresponding author**: Abbas Taleb Khleif

status of the aquatic environment among other species (Farkas and Salanki, 2002; Al-Yousuf and El-Shahawi, 1999). Heavy metals in fish come predominantly from their diet, and contaminant bioaccumulation levels are higher in fish that are higher in the food chain (EFSA, 2005). Heavy metals penetrate fish bodies in three possible ways: through gills, through the digestive tract, and through the surface of the body. The gills are regarded as the critical site of direct absorption of water metals (Romeo *et al*., 1999; Beijer and Jernelov, 1986). Affected organisms show response to heavy metals by accumulating them in their bodies or by transferring to the next trophic level of the food chain (Shah and Altindag, 2005). Fishes are good Indicators of contamination of trace metals and the possible risk of human use (Papagiannis *et al*., 2004). the adverse effects of these contaminants can and cannot avoid (Olaifa *et al*., 2004).

As they reach a high trophic level and are a significant source of balanced protein in the human diet, fish are also seen as a significant bio-indicator of the aquatic environment. Due to their value in the human diet, fish must be carefully screened to ensure that the intake of fish does not transfer harmful amounts of heavy metals to the human population (Rahman *et al*., 2012). Monitoring the contamination of heavy metals in river systems by the use of fish tissues helps determine the quality of aquatic environments (Adam, 2002). In this context, fish samples are considered one of the most significant variables in estimating the contamination of trace metals in freshwater systems (Cinier *et al*., 1999; Has-Schön *et al*., 2006; Rashed, 2001). In this context, fish samples are considered one of the most significant variables in estimating the contamination of trace metals in freshwater systems (Canli *et al*., 1998; Yilmaz, 2003; Henry *et al*., 2004). Each species of fish has a specific way of accumulating (and/or removing) metal when exposed to such contaminants (Peakall and Burger, 2003). Fish in the upper food web role, on the other hand, are likely to accumulate metals and cause human contamination through foods that cause chronic and acute diseases (Has-Schön *et al*., 2006; Al-Yousuf, 2000).

The level of trace metals in various fish organs is used as an ecosystem metal contamination index, which is considered to be an important instrument to highlight the role of elevated metal levels in aquatic species (Tarrio *et al*., 1991). Metal concentrations are harmful to fish if their level reaches the acceptable level (Mansour and Sidky, 2002).

The aim of this research was intended to determine the concentrations of heavy metals (Pb, Cd, Se, Ni, Fe, Mn and Zn). Three distinct weight and length types in water and muscle *Carassius auratus* (L.) collected from three sites of the Euphrates river. Since, this fish is an essential component of this zone's human diet. The findings of this analysis will include details on the background levels of metals in water and fish species, contributing to the successful monitoring of both the quality of the atmosphere and the health of the inhabiting species the river ecosystem.

2. Materials and Methods

Gold carp samples were collected *Carassius auratus* (L.) and water is seasonal from three locations on the Euphrates river, which is the Al- Hindiya barrage (first site) and Touirij (second location) and the Kifil (Figure - 1). The collected fish samples were divided into three longitudinal and weight categories. The samples were collected for the period 2015 - 2016, and the water samples were taken from the middle of the river using clean polyethylene bottles washed with acid and distilled water distilled for the purpose of examining some physical and chemical properties and to measure the concentrations of some trace elements in water.

Carassius auratus (L.) belongs to the Cyprinoidae family and is considered one of the fishes that have a great economic value in Iraqi waters, and indicated that this type of fish is frequently found in the central and southern sections of Iraq, and carp is considered one of the most resistant to environmental conditions (Al-Daham, 1977). Difficulty In addition to having a good sexual growth and maturity (Jeney and Jeney, 1995).

Certain physical and chemical properties of the collected water samples from the river water which were related to its effect on the concentrations of trace elements were increased or decreased which are the water temperature, the electrical conductivity EC, and the pH of the river water. Amount of DO, and total dissolved solids TDS. Total solids suspended from TSS in addition to salinity. The concentration of dissolved trace elements in river water was calculated using the method described by (Rileyand Taylor, 1968). As for the trace elements in the particulate phase, it followed the method (Sturgeon *et al*., 1982). The sample of each of the classes of the *Carassius auratus* (L.) grouped and divided according to weight and length according to (ROPME, 1982). was digested after the muscle tissue was separated from the bone and severed and well mixed and dried with an oven at a temperature of 70 degrees Celsius, then all samples were measured using an Atomic device Absorption spectrophotometer-Model (5000).

Statistical Analysis

All the data was expressed as ± SD. For mean separation, the minimum significant difference (LSD) was used. The significant level was set at the likelihood level of $P<0.05$.

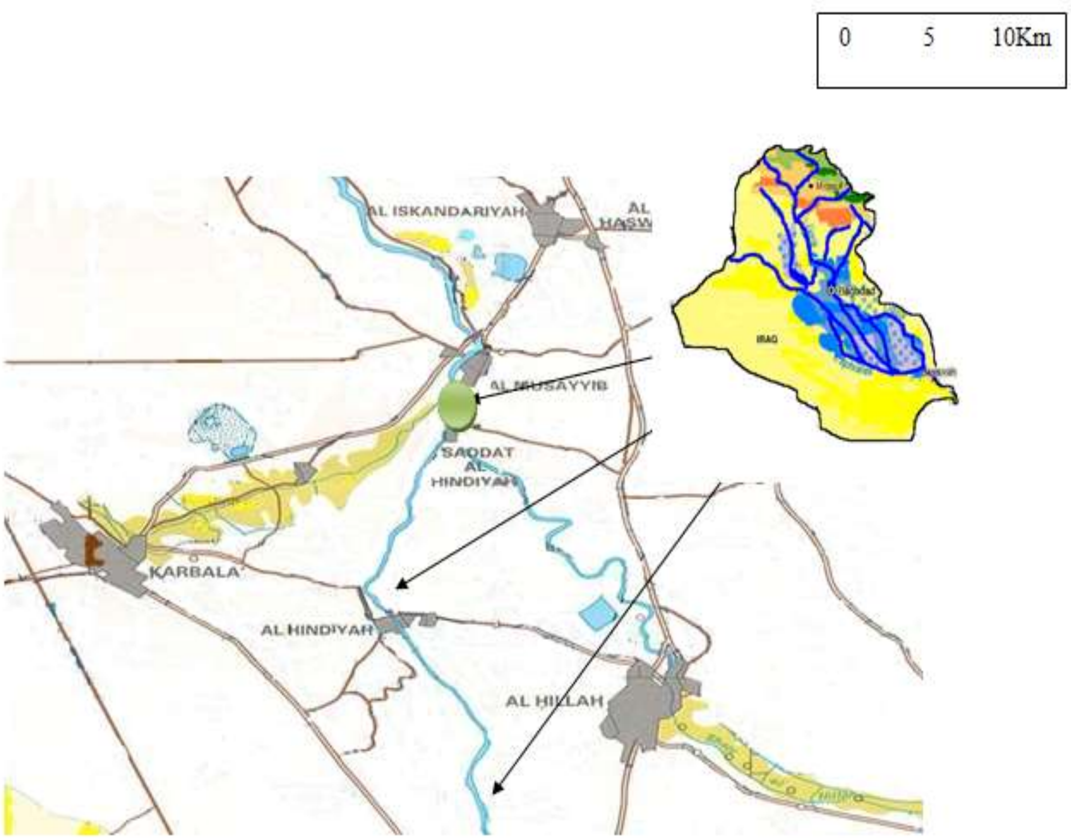


Figure - 1: The study site on the Euphrates River, Iraq

3. Results and Discussion

The rapid growth of industry and agriculture has resulted in increased emissions of heavy metals in recent decades, which poses a major environmental risk to invertebrates, fish and humans (Uluturhan and Andkucuksezginf, 2007). Heavy metals should be highlighted among the pollutants, because of the effects of their bioaccumulation in marine environments (Nadmitov *et al*., 2015; Slomanka, 2007). Significant amounts of these metals are released into waterways where they can be highly deposited and biomagnified in the water, soil and aquatic food chain, resulting in both sub-lethal effects and deaths in local fish populations (Megeerj *et al*., 2000; Xu *et al*., 2004; Salman *et al*., 2014).

The Table - 1 shows the ranges of lengths and weights of the golden carp fish *Carassius auratus* (L.) grouped from three study sites located on the Euphrates for the period 2015 - 2016, while Table - 2 shows the difference in the seasonal values of some characteristics. The physical and chemical properties of the Euphrates River in the study sites. Table - 3 shows the seasonal concentrations of the studied heavy elements (Cd, Pb, Zn, Fe, Mn, Se and Ni) in the soluble and particulate form of the Euphrates water in the studied sites and the Table - 4 shows the seasonal concentrations of the seven heavy elements studied in the muscles of the three classes of *Carassius auratus* (L.).

The results of the current study found the annual rates of heavy metals concentrations in the waters of the river as dissolved form were The order of has been taken as follows:

Iron>Zinc>Nickel>Manganese>Cadmium>Lead> Selenium

While the concentrations of these elements in water as particular form have taken the following order:

Iron>Zinc>Manganese>Cadmium>Lead>Nickel> Selenium.

Heavy elements in the water as a particular form in the present study had higher concentrations compared with the dissolved form and this is attributed to the process of adsorption, as these elements tend to linkage on the surfaces of some materials, especially particulate matter and organic mud that spreading in the water column (Demina *et al*., 2009; Al-Sultany, 2018).

The results of the current study stated that there is a quarterly variation in the concentrations of the studied elements, the highest concentrations was recorded in summer, while lowest concentrations were in winter and for both forms dissolved and particular due to the large number of pollutant sources and to the difference in capacity of the river to receive different amounts of discharged substances, As that Discharges from domestic, manufacturing and other man-made activities have contributed to high levels of concentrations of heavy metals in freshwater (Vinodhini and Narayanan, 2008).

In addition to the difference in temperature between seasons, which affects directly and indirectly on the concentration of trace elements in water, or may be due to differences in the values of both pH and the values of salinity and water hardness in addition to the difference in the amount of total dissolved substances, as well as total suspended materials that directly affects the readiness of the elements for living organisms (Kumar and Achyuthan, 2007; Al-Sultany, 2014).

Mitigating factor may play the primary role in influencing the concentration of elements in addition to the change in the water level of river, and may be the life activities for some organisms also play a role in influencing the concentration of these elements, which in turn is affected by many factors including the amount of food, reproduction and the length of the lighting (Salman, 2011). Also, as a result of the study, the low concentrations of some elements in some seasons, is because of the ability of these elements to accumulate in the bodies of living organisms, or to be removed continuously by removal process or by the linkage with through the process of adsorption on some suspended substances materials and therefore deposition (Dhurgham *et al*., 2014).

The relationship between some physical and chemical properties of water with a concentration of heavy metals dissolved and particulate matter shown by the results of statistical analysis, it was found that there is a direct significant correlation relationship between the concentration of heavy studied elements in the water of the river and the temperature, as it increases the concentration in hot seasons because of the high temperature (Abdand Musa, 2009). The cause of the low concentration of elements in the spring is due to that this season is the growing season and thus the plants absorb the bulk of these elements in this season because they are necessary to complete the biological processes, while in the summer, the concentration of these elements increase due to several reasons, mainly because of the high temperature and thereby increase the evaporation rates as well as increased degradation of the dead organisms which leads to lack of absorption of these elements by the living organisms. Bacteria, especially, anaerobic sulfur bacteria a key role in the reduction of most of these elements as the heavy elements mixed with organic materials through analysis by bacteria (Park *et al*., 2008).

The results of the present study showed that the concentration of heavy elements in the waters of the river both in dissolved and particular form affected by the values of pH, as the results of statistical analysis shown there is a reverse correlation between them, as the pH of water affect the solubility of heavy metals by increasing the amount of adsorbed elements on organic matter by the increase of the pH values and thus lead to the deposition (Odum, 2000). While the decrease in the pH values will lead to increase competition between the elements ions and hydrogen ion to link to active sites, also it's working to dissolve the complex (carbonate/ elements), leading to release the items to the water column (Forstner and Wittmann, 1981).

The electrical conductivity and salinity have been found by the results of statistical analysis that there is a significant reverse between them and the concentration of studied heavy elements as they affect the process of absorption and adsorption of these elements in organic matter (Kathikeyani *et al*., 2002). The results of statistical analysis of the current study that the amount of total suspended Substances associated closely to the concentration of river water as particular form due to the abundance of phytoplankton in the Euphrates River, as the plankton concentrate large amounts of heavy elements in the water through absorption (Dhurgham *et al*., 2014). The results of the present study showed that the annual mean concentration of the studied heavy metals (Cd, Pb, Zn, Fe, Mn, Se, Ni) in the muscles of the first category, second and third of the Gold carp fish *Carassius auratus* (L.). The arrangement in the muscles of the three groups in the studied sites is as follows:

Zinc>Iron>Nickel>Manganese>Selenium>Lead> Cadmium.

The current study showed that the third category of fish *Carassius auratus* (L.) contained the highest concentrations of heavy elements than for first and second category, and this may be because the increase of concentration of the element by the increase of the size and length of fish (Al-Sultany, 2014; Blasco *et al*.,1998). The concentration of Zinc element, as is evident from the results was high compared to other elements and the reason This component is important for preserving the gonads and protecting the marine ecosystem from the effects of cadmium toxicity, and this purposely fishes to consume large quantities of this component (Al-Sultany, 2014; Hammoud *et al*., 2005). Add to that the study showed that In the muscles of the three types of fish studied, the concentration of the selenium element was high and there was proof of the absorption of that element from water into the bodies of living organisms, including fish, and this is strong evidence on the basis of fish as a critical indicator for suggesting the existence of pollution of these dangerous heavy elements (Benson *et al*., 2007).

Table – 1: Ranges length and weight for *Carassius auratus* (Linnaeus) collected from the Al-Euphrates river

Categories / Seasons		Al- Hindiya barrage	Al- Hindiya	Al-Kifll
Spring	W(g)	31.3 – 34.7	51.2 – 54.6	**74.8 – 75.9**
	L(cm)	12.9 – 14.7	16.4 – 17.4	**17.4 – 19**
Summer	W(g)	31.8 – 34.1	54.7 – 57.4	**76.1 – 77.8**
	L(cm)	12.2 – 14.1	16.1 – 17.2	**18.5 – 19.7**
Autumn	W(g)	28.1 – 29.8	49.8 – 52.3	**75 – 77.1**
	L(cm)	12.3 – 14	15.7 – 16.4	**17.3 – 18.9**
Winter	W(g)	27.9 – 30.1	52.3 – 56.3	**75.7 – 78.1**
	L(cm)	**12.9 – 15.1**	**16.8 – 17.3**	**18.1 – 19.9**

Table – 2: Seasonal differences in Physical – Chemical characteristic for Water Al-Euphrates river

Sites	Al- Hindiya barrage				Al- Hindiya				Al-Kifll			
Properties	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter
Temperature (˚C)	22	40	23	18	20	40	21	18	21	39	23	**19**
EC. (µs /cm)	729	859	800	732	791	853	761	738	806	843	721	**755**
pH	7.5	7.5	7.2	7.4	7.6	7.1	7.2	7.5	7.9	7.8	7.4	**7.6**
DO (mg/L)	7.6	5.9	7.8	8.9	7.2	6.2	8	9.6	7.9	6	7.5	**9.2**
T.D.S. (mg/L)	41.7	40.8	50.9	41.5	42.6	42.8	49.1	43.8	41.8	42.5	50.4	**40.2**
T.S.S. (mg/L)	453.7	461.2	482.7	542.8	427.8	467.9	482.8	537	462.8	471.2	490.7	**516.4**
Salinity (%)	0.451	0.542	0.483	0.438	0.468	0.574	0.486	0.421	0.468	0.548	0.503	**0.423**

Table – 3: The seasonal concentrations of the studied heavy elements (soluble and particulate) form of the Euphrates water in the studied sites

Elements Sites	Seasons	Pb		Cd		Se		Ni		Fe		Mn		Zn	
		D. (P.P.M)	P. (P.P.M)	D. (P.P.M)	P. (P.P.M)	D. (P.P.M)	P. (P.P.M)	D. (P.P.M)	P. (P.P.M)	D. (P.P.M)	P. (P.P.M)	D. (P.P.M)	P. (P.P.M)	D. (P.P.M)	P. (P.P.M)
Al- Hindiya barrage	Spring	2.1	42.1	6.3	61.8	0.9	1.45	5.9	11.3	20.6	812.9	8.2	78.3	22.6	158.2
	Summer	3	46.3	6.8	64.3	1.2	1.93	12.4	16.4	20.8	1119.6	11.3	98.4	21.7	146.7
	Autumn	1.84	34.8	6	59.5	0.9	1.3	6.9	14.8	19.8	942.7	9.5	80.4	19.3	139.4
	Winter	0.9	31.5	5.8	59	0.8	1	8.4	9.7	19.7	1092.8	9.2	72.6	20.8	141.6
	Rate	1.85	38.675	6.225	61.15	0.95	1.42	8.4	13.05	20.225	992	9.55	82.425	21.1	146.47
Al- Hindiya (Touirij)	Spring	1.9	43.6	6	58.6	1	1.34	7.3	9.6	21.2	937.6	8.94	76.8	21.7	151.4
	Summer	2.8	48.1	5.8	65.9	1.5	2.14	11.6	15.8	22.1	1094.2	10.84	94.8	20.8	148.2
	Autumn	1.2	38.7	5.5	60	0.9	1.4	6.12	14.9	19.4	963.7	8.34	91.4	18.4	142.7
	Winter	1	36	5.3	57.3	0.7	1.34	7.32	10.3	18.3	997.8	9.42	81.5	20.7	146.7
	Rate	1.525	41.6	5.65	60.45	1.025	1.555	8.085	12.65	20.25	998.32	9.385	86.125	20.4	147.25
Al- Kifil	Spring	2.6	40.1	6.4	60.8	0.8	1.68	8.61	10.4	20.7	895.1	8.51	84.6	22.6	150.1
	Summer	2.8	42.8	6	67.2	1.6	1.94	12.9	15.3	21.5	1167.2	10.7	100.2	20.4	149.2
	Autumn	1.6	38.6	5.2	59.4	0.9	1.47	7.9	14.7	19.3	952.4	8.31	78.6	19.2	148.4
	Winter	1.4	39.1	5.2	59.8	0.8	1.24	7.1	9.8	17.9	982.6	8.14	72.8	20.9	142.9
	Rate	1.9	40.15	5.7	61.8	1.025	1.583	9.128	12.55	19.85	999.32	8.915	84.05	20.775	147.65

Table – 4: The seasonal concentrations of the seven heavy elements studied In the muscles of the three Categories of *Carassius auratus* (Linnaeus).

Elements Sites	seasons	Pb			Cd			Se			Ni			Fe			Mn			Zn		
		1 Cat.	2 Cat.	3 Cat.	1 Cat.	2 Cat.	3 Cat.	1 Cat.	2 Cat.	3 Cat.	1 Cat.	2 Cat.	3 Cat.	1 Cat.	2 Cat.	3 Cat.	1 Cat.	2 Cat.	3Cat.	1 Cat.	2 Cat.	3 Cat.
Al- Hindiya barrage -	Spring	0.321	0.542	0.637	0.102	0.201	0.321	1.42	1.7	1.91	5	6.4	8.4	16.1	17.4	19.1	1.721	1.824	1.972	18.24	18.93	19.87
	Summer	0.412	0.586	0.791	0.121	0.294	0.397	1.64	1.68	2.3	6.10	6.9	8.9	16.9	17.6	19.7	1.834	1.986	2.1	18.47	19.02	20.17
	Autumn	0.247	0.397	0.516	0.098	0.2	0.298	1.43	1.67	1.93	5.4	7.3	8.1	15.4	16.4	17.8	1.687	1.721	1.834	18.01	19.01	19.46
	Winter	0.197	0.324	0.491	0.092	0.201	0.298	1.5	1.73	1.83	5.3	7	8.4	15.4	16	17	1.6	1.701	1.8	17.86	18.54	19.56
	rate	0.294	0.456	0.609	0.103	0.224	0.329	1.497	1.69	1.99	4.36	6.9	8.45	15.95	16.85	18.4	1.71	1.808	1.926	18.14	18.85	19.76
Al- Hindiya (Touirij)	Spring	0.375	0.594	0.764	0.115	0.2	0.305	1.54	1.72	2	5.6	6.8	8.7	16.4	17.2	18.4	1.671	1.869	1.972	18.01	19.24	20
	Summer	0.471	0.601	0.763	0.134	0.246	0.4	1.58	1.81	1.8	6	7	9	16.8	17.8	19.6	1.824	2	2.014	18.67	19.42	20.00
	Autumn	0.298	0.415	0.486	0.091	0.241	0.3	1.48	1.64	1.89	5.8	7.2	8	15.3	16.7	17.4	1.643	1.752	1.824	17.98	18.76	19
	Winter	0.247	0.396	0.432	0.091	0.198	0.284	1.52	1.6	1.96	5.9	6.31	8.4	15.2	16.1	17.4	1.601	1.7	1.821	17.90	18.67	19.43
	Rate	0.348	0.502	0.611	0.108	0.221	0.322	1.53	1.69	1.91	5.82	6.83	8.52	15.92	16.95	18.2	1.684	1.83	1.907	18.14	19.02	19.60
Al- Kifil	Spring	0.361	0.571	0.726	0.1	0.203	0.367	1.39	1.69	2.1	5.2	6.7	8.1	16	17	18.5	1.725	1.873	1.947	18.251	19.2	20.134
	Summer	0.394	0.61	0.712	0.12	0.287	0.384	1.56	1.72	1.94	5.9	7.1	8.73	16.7	17.3	19.8	1.842	1.971	2.034	18.432	18.937	20
	Autumn	0.267	0.431	0.521	0.084	0.203	0.318	1.5	1.7	2	5.7	6.4	8.6	15.7	16.7	17.3	1.7	1.73	1.826	18	18.967	19.867
	Winter	0.21	0.317	0.541	0.1	0.2	0.301	1.48	1.8	1.97	5.4	6.82	8.1	15	16.4	17.4	1.604	1.7	1.801	18	18.938	19.527

The relationship between the concentrations of heavy metals studied in the muscles of *Carassius auratus* (Linnaeus) with some studied physical and chemical properties, they found a direct significant correlation relationship between temperature and the amount of heavy elements, with the highest concentration of these elements in fish muscle was in summer, spring and attributed the reason to increase the accumulation of heavy elements in the warm seasons compared to the cold seasons, as the high temperature causes an increase of metabolic events and the high level of metabolism and thereby increase the concentration of heavy elements within the body of fish (Zayed *et al*., 1994).

In fresh water, heavy metals accumulate and grow through the food chain. The bioaccumulation patterns of heavy metals are calculated by fish absorbance and excretion rates. Different variables such as water's physical and chemical properties as well as seasonal changes are the explanation for substantial metal augmentation in various fish tissues (Romeo, 1999). Stern metal residual problems in the fish epithelium are due to the presence of higher concentrations of metal in water (Wong *et al*., 2001).

4. Conclusion

The concentration of heavy elements in the waters of the Euphrates River as particular form was higher than compared to dissolved due to the adsorption of elements on the suspended Substances in the water. The quarterly variation in the concentrations of heavy metals studied in both in water as dissolved and particular in the muscles of Gold carp fish *Carassius auratus* (Linnaeus). It was high in summer compared to winter. Third longitudinal and weighing category recorded Gold carp fish *Carassius auratus* (Linnaeus) high concentrations of heavy studied elements, and higher than the first and the second categories, due to the difference in the speed of growth in addition to the length of exposure.

A significant positive correlation recorded between the concentrations of heavy studied metals in water (dissolved and particular) and in fish muscle with temperature, while a reverse significant correlation was found between the concentration of elements in the water with the pH, salinity and electrical conductivity. A significant direct relationship correlation between the concentrations of seven studied elements in the waters of the Euphrates River as particular with the amount of total suspended Substances.

Acknowledgements

Authors contributions and Acknowledgements Not applicable' for that section .

Funding

The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

Financial interests

The authors have no relevant financial or non-financial interests to disclose.

Author Contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by [Dhurgham A. A. Al-Sultany], [Sadiq Sahib Mohammed] and [Abbas T. Khlaif]. The first draft of the manuscript was written by [Dhurgham A.A. Al-Sultany] and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Data Availability

The datasets generated during and/or analyzed during the current study are available in the [Al-Qasim Green University] repository.

Consent to participate

Informed consent was obtained from all individual participants included in the study.

@Ethics approval and consent to participate 'Not applicable' for that section.

Consent for publication 'Not applicable' for that section.

Competing interests 'Not applicable' for that section.

5. Reference

1) Abd, A. K. M and Musa, Z. J. (2009). A study of levels of trace elements in water and soil of Hamadan Canal and Its Effect on leaves fruits of Braim and Hillawi Cultivars of date palms. *Marsh Bulletin*, 4(1): 85 – 97.
2) Adam, S. M. (2002). Biological indicators of aquatic ecosystem stress. 656. Bethesda, MD: American Fisheries Society.
3) Akinmoladun, A. C., Ibukun E., Afor E., Obuotor E and Farombi E. (2007). Phytochemical constituent and antioxidant activity of extract from the leaves of *Ocimum gratissimum*. *Sci. Res. Essay*, 2: 163 - 166.
4) Al-Daham, N. Q. (1977). Iraq and the Arabian Gulf Fish, Publications Center for Arab Gulf Studies, University of Basra, 9: 546.
5) Al-Yousuf M. El-Shahawi M. (1999). Trace metals in *Lethrinus lentjan* fish from the Arabian Gulf (Ras Al-Khaimah, United Arab Emirates): Metal accumulation in kidney and heart tissues. *Bull Environ Contam. Toxicol.*, 62: 293 - 300.
6) Al-Yousuf, M. H., El-Shahawi, M. S and Al-Ghais, S. M. (2000). Trace metals in liver, skin and muscle of *Lethrinus lentjan* fish species in relation to body length and sex. *The Science of the Total Environment*, 256: 87 – 94.
7) Beijer K and Jernelov A. (1986). Sources, transport and transformation of metals in the environment. Handbook on the toxicology of metals. Elsevier, Amsterdam. pp, 68-84.
8) Benson, N. U., Essien, J. P., Williams, A. B and Bassey, D. E. (2007). Mercury accumulation in fishes from tropical aquatic ecosystems in the Niger Delta, Nigeria. *Current Science*, 92(6): 781 – 785.
9) Blasco, J., Rubio, J. A., Forja, J., Gómez-parra, A and Establier, R. (1998). Heavy Metals in some Fishes of the Mugilidae Family from Salt Ponds of Cádiz Bay, Sw Spain. *Ecotoxicology and Environmental Restoration*, 1(2): 71 – 77.
10) Canli, M., Ay, O and Kalay, M. (1998). Levels of heavy metals (Cd, Pb, Cr and Ni) in tissue of *Cyprinus carpio*, *Barbus capito* and *Chondro stomaregium* from the Seyhan river, Turkey. *Turkish Journal of Zoology*, 22: 149 – 157.
11) Cinier, C. C., Petit-Ramel, M., Faure, R., Garin, D and Bouvet, Y. (1999). Kinetics of cadmium accumulation and elimination in carp *Cyprinus carpio* tissues. *Comparative Biochemistry and Physiology*, 122: 345 – 352.
12) Conacher H and Mes J. (1993). Assessment of human exposure to chemical contaminants in foods. *Food Addit. Cont.*, 5: 10 – 15.
13) Demina, L. L., Galkin, S. V and Shumilin, E. N. (2009). Bioaccumulation of some trace elements in the biota of hydrothermal fields of the Guaymas Basin (Gulf of California). *Boletin De LA Sociaeded Geologica Mexicana*, 61(1): 31– 45.
14) Dhurgham A.A.A., Hazim A. H and Mayson M. A. T. (2014). Pollution of Selenium and Nickel Elements in the Water and three Types of Muscles Fish Collected from the Euphrates River, Central Iraq. *Advances in Environmental Biology*, 8(15): 72 - 78.
15) Dhurgham Ali Al-Sultany (2014). Estimate the concentration of some heavy metals in the muscles of hamri fish *barbus luteus* (heckel) collected in the Euphrates river of Iraq. *Euphrates Journal of Agriculture Science*, 6(4): 1 - 14.
16) Dhurgham, A and A. Al-Sultany. (2018). Estimation of concentrations of some pollutants of trace elements in the site of the Indian dam, Euphrates River and the effect of their presence on the muscles of

the lignified fish Liza Abu Heckel, AL-Bahir Quarterly Refereed. *Journal for Natural and Engineering Science*, 27 - 42.

17) EFSA. (2005). Opinion of the Scientific Panel on contaminants in the food chain related to the safety assessment of wild and farmed fish.
18) Farkas A and Salanki J. (2002). Specziar A. Relation between growth and the heavy metal concentration in organs of bream *Abramis brama* L. populating Lake Balaton. *Arc. Environ. Contam. Toxicol.*, 43: 236 - 243.
19) Forstner, U and Wittmann, G.T.W. (1981). Metal pollution in the aquatic environment. *Springer-Verlag, New York.*
20) Hammoud, V., Okda, M. and Saad, A. (2005). Fact concentrations of some heavy metals in tissue of different thickness Alsrgos *Diplodus sargus* in the Syrian coastal waters. *Basil Al-Assad Journal of Engineering Science*, 21: 37 - 45.
21) Has-Schön, E., Bogut, I and Strelec, I. (2006). Heavy metal profile in five fish species included in human diet, domiciled in the end flow of river Neretva (Croatia). *Archives of Environmental Contamination and Toxicology*, 50: 545 – 551.
22) Henry, F., Amara, R., Courcot, L., Lacouture, D and Bertho, M. L. (2004). Heavy metals in four fish species from the French coast of the Eastern English Channel and Southern Bight of the North Sea. *Environmental International*, 30: 675 – 683.
23) Jasim M. Salman, Mayson M. Salah and Dhurgham A. Al-Sultany. (2014). Spatial variation of Composition and Distribution of Fish in Two sites on Euphrates river, Middle of Iraq. *Journal of Al-Kufa University for Biology*, 6(2): 14 – 22.
24) Jeney, Z and Jeney, G. (1995). Recent achievements in studies on diseases of cdmmon carp (*Cyprinus carpio* L.), *Aquaculture*, 129: 397 – 420.
25) Kathikeyani, T. P., Velavan, T. P., Ramesh, M. (2002). Physico–chemical characterization of the river Shanmuganadhi, Tamil Nadu. *Env. Eco.*, 20(2): 482 – 486.
26) Kumar, K. A and H. Achyuthan. (2007). Heavy metal accumulation in certain marine animals along the East coast of Chennai, Tamilnadu, India, 28: 637 – 643.
27) Mansour, S. A and M. M. Sidky. (2022). Ecotoxicological studies: Heavy Metals Contaminating Water & Fish from Fayum, Egypt. *Food Chemistry*, 78(1): 15 - 22.
28) Megeerj, S., Mcdonald, D and Wood, C. (2000). Effect of Chronic Sublethal Exposure To Waterborne Cu, Cd, Or Zn in Trout. *Aquatic Toxicology*, 50: 231 - 243.
29) Nadmitov B., Hong S., Inkang S., Chujm, Gomboev B., Janchivdorj and Khimjs. (2015). Large scale monitoring and Assessment of Metal contamination in Surface water of the Selenga. *Environ. Sci. Pollut. Res.* 22(4): 2856 - 2867.
30) Odum, H. T. (2000). Heavy metals in the environmental using wetlands for their removal. *Lewis Publishers.*
31) Olaifa, F. E., A. Olaifa, A. Adelaja and A. G. Owolabi. (2004). Heavy metal contamination of *Clarias gariepinus* from a Lake and Fish farm in Ibadan, Nigeria. *African J. Biomed. Res.*, 7: 145 - 148.
32) Papagiannis, I., I. Kagalou, I Leonardos, D. Petridis and V. Kalfakakou. (2004). Copper and zinc in four freshwater fish species from Lake Pamvotis (Greece). *Environ. Int.*, 30: 357 – 362.
33) Park, N., Kim, J. H and Cho, J. (2008). Organic matter, anion, and metal wastewater treatment in Damyang surface constructed wetlands in Korea. *Ecological Engineering Journal*, 32(1): 68 - 71.
34) Peakall, D and Burger, J. (2003). Methodologies for assessing exposure to metals: Speciation, bioavailability of metals and ecological host factors. *Ecotoxicology and Environmental Safety*, 56: 110 – 121.
35) ROPME. (1982). Manual of oceanographic observation and pollution analysis methods. ROPME/P.O. Box. 16388, 13124 Safa, Kuwait.

36) Rahman, M. S., A. H. Molla, N. Saha, and A. Rahman (2012). Study on heavy metals levels and its risk assessment in some edible fishes from Bangshi River, Dhaka, Bangladesh. *Food Chemistry*, 134: 1847 – 1854.
37) Rashed, M. N. (2001). Monitoring of environmental heavy metals in fish from Nasser Lake. *Environment International*, 27: 27 – 33.
38) Riley, J. P and D. T. Taylor. (1968). Chelating resins for the concentration of trace elements from sea water and their analytical use in conjunction with alomic absorption spectrophotometry. *Anal. Chim Acta.*, 40: 479 - 485.
39) Romeo M., Siau Y., Sidoumou ZÌn, (1999). Gnassia - Barelli M. Heavy metal distribution in different fish species from the Mauritania coast. *Sci. Total Environ.*, 232: 169 - 175.
40) Salman, J. M. (2011). The Clam *Pseudodontpsis euphraticus* (Bourguignat, 1852) as a Bioaccumulation Indicator Organism of Heavy Metals in Euphrates River, Iraq. *J. of Babylon University*, 19(3): 115 - 122.
41) Shah S. L and Altindag A. (2005). Alterations in the immunological parameters of Tench after acute and chronic exposure to lethal and sublethal treatments with mercury, cadmium and lead. *Turk. J. Vet. Anim. Sci.*, 29: 1163 - 1168.
42) Slomanka, L. (2007). Effect of Trace Metals on Salmonid Fish. The Role of Social Hierarchies. *Appl. Anim. Behav. Sci.*, 104: 326 - 345.
43) Sturgeon, R. E., J. A. Desaulincrs, S. S. Berman and D. S. Russell. (1982). Determination of trace metals in estuarine sediment by graphite fernace atomic absorption spectrophotometry. *Anal. Chem. Acta.*, 134: 288 - 291.
44) Tarrio, M. Jaffor and M. Ashraf. (1991). Levels of Selected Heavy Metals in Commercial Fish from Five Fresh Water Lake in Pakistan. *Toxicological and Environmental Chemistry*, 33(2): 133 -140.
45) Uluturhan E and Kucuksezgin F. (2007). Heavy Metal Contaminants in Red Pandora (*Pagellus erythrinus*) Tissues from the Eastern Aegean Sea, Turkey. *Water Research*, 41: 1185 - 1192.
46) Velez D and Montoro R. (1998). Arsenic speciation in manufactured seafood products. *J. Food Prot.*, 61: 1240 - 1245.
47) Vinodhini, R and M. Narayanan. (2008). Bioaccumulation of heavy metals in organs of fresh water fish *Cyprinus carpio* (Common carp). *Int. J. Environ. Sci. Technol.*, 5(2): 179 - 182.
48) Vosylien Ä. M and Jankait, Ä. A. (2006). Effect of heavy metal model mixture on rainbow trout biological parameters. *Ekologija*, 4: 12 - 17.
49) Wong C, Wong P and Chu L. (2001). Heavy metal concentrations in marine fishes collected from fish culture sites in Hong Kong. *Arch. Environ. Contam. Toxicol.*, 40: 60 - 69.
50) Xu Y, Liu X and Maa J. (2004). Current Research on Toxicity effect and Molecular mechanism of Heavy metals on Fish. *Mar. Sci.*, 28: 67 - 70.
51) Yilmaz, A. B. (2003). Levels of heavy metals (Fe, Cu, Ni, Cr, Pb, and Zn) in tissue of *Mugil cephalus* and *Trachurus mediterraneus* from Iskenderun Bay, Turkey. *Environmental Research*, 92: 277 – 281.
52) Zayed, M. A., Eldrin, F. A. N and Rabie, K. A. (1994). Comparative Study of seasonal variation in metal concentrations in river Nile sediment, fish and water by atomic absorption spectrophotometry. *Microchemical Journal*. 49: 27 - 35.

Access this Article in Online

Quick Response Code	
Website	**www.jpsscientificpublications.com**
DOI Number	**DOI: 10.22192/lsa.2022.8.6.1**
Thomson Reuters Researcher ID	**L – 5547 – 2016**
ISI Impact Factor	**4.206**

How to Cite this Article:

Abbas Taleb Khleif, Sadiq Sahib Mohammed and Dhurgham A.A. Al-Sultany. (2022). Estimation of Pollution by Some Heavy Metals in Muscles of *Carassius auratus* (L.) Fish Collected from the Euphrates River, Central Iraq. *Life Science Archives*, 8(6): 2517 – 2528.

DOI: 10.22192/lsa.2022.8.6.1