

Measurement of Bioaccumulation of Some Heavy Elements in *Sinanodonta woodiana* and *Corbicula fluminea* In Al-Gharaf River, Thi-Qar Governorate, Iraq

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ABSTRACT

The current study was conducted in the period October 2023 to September 2024, the study aimed to measure the concentrations of some heavy metals in water and sediments and their bioaccumulation in the soft tissues of two species of molluscs *Corbicula fluminea* and *Sinanodonta woodiana*. Water samples, sediments and molluscs were collected from four stations on the Gharraf River in southern Iraq and the order of the elements in the water was Pb>Zn>Ni>Cu>Cd>Cr>As and in the sediments Ni>Zn> Cu> Pb >Cr >Cd >As and in *C.fluminea* was Zn>Ni>Pb>Cu>Cr>Cd>As and in *S.woodiana* was Ni>Zn>Pb>Cu>Cr>Cd>As. The highest concentrations of elements were recorded in the third and fourth stations and the concentrations were in the first and second stations. The results showed seasonal variation in the concentrations of elements in the water, sediments and soft tissues of molluscs in the Gharraf River, which indicates high rates of pollution in its water.

Keywords: Molluscs, Heavy elements, pollution, *S. woodiana*, *C. fluminea*

INTRODUCTION

Mollusca are known for their important role in freshwater ecosystems as they serve as a food source for many organisms, including fish. In addition, it contribute to maintaining water quality by consuming large amounts of waste and algae, which helps maintain a balanced ecosystem (Jawed *et al.*,2022). Molluscs are endemic in most areas of the earth, where they live in the oceans as well as in fresh water and the land environment such as snails and slugs. Moisture is necessary for the bodies of molluscs to keep them active (Gilpin, 2006). The life cycle of molluscs is generally short, but some of them may live for several years, such as clams, where they live about ten years, and freshwater snails live about

four to five years (**Hichman et al.,1974**), clams and bivalves are among the most aquatic organisms that meet most of the specifications that must be met in biomarkers, where the absorption of heavy elements depends on their types, the period of prosperity of organisms and their sensitivity to light ,(**Forstner and Wittmann 1981**).

Metallothionine is an important binding protein with a low molecular weight (6-7) KD, which plays an important role in the detoxification of toxic chemicals and has a role in maintaining the balance of essential minerals and uses biomarkers to assess the toxicity of contaminants (**Huange et al., 2007**). Multiple forms of MT are likely to play different physiological roles, and the importance of MT in detoxification processes depends on environmental conditions and animal populations, (**Amiard et al., 2006**). MT is involved in the detoxification, transport and storage of heavy metals by isolating them and preventing them from binding to target biochemical sites in cells ,(**Maltez et al., 2009**).

Molluscs can reproduce through various methods, including sexual and asexual reproduction. Many species are dioecious (have separate male and female individuals), while others are hermaphrodites, and most molluscs lay eggs that can be fertilized externally or internally. The eggs are often laid in protective capsules or blocks to protect them from predators and environmental conditions, and then the larva stage known as Trochophorus which allows them to spread in the water column and can help them find habitats and reduce competition with adults ,(**Mckenzie, T. 1982**).

Environmental factors such as seasonal changes, population density and general environmental conditions significantly affect sex contrast in bivalve (**Patel, B. 2023**). These chemicals can accumulate in oyster tissue and negatively affect their biological functions, leading to stress responses that may lead to sexual inversion, food shortages are another factor that can contribute to sex change Also, in areas with high levels of pollution, sexual inversion can be as high as 58% among female clams. (**Waykar, B., & Deshmukh, G. 2011**).

MATERIAL AND METHODS

1-Study Area

The Gharraf River is one of the main and important rivers that have an important and significant role in irrigating the lands of the Gharraf Basin and large cities such as the city of Wasit (**Hussein ,2007**), were chosen four stations in our study on the Gharraf River, starting from the first station near Al Suleiman Bridge 31.406701, 46.282212, the second station is located near Nazim Al-Bada'a 31.446041 46.175926, the third station is in the Abu Shabiba area 31.355805, 46.191544, and the fourth station is close to the Gharraf water station 31.290445, 46.250925.

2- Sample collection

Samples were collected on a monthly basis, starting from October 2023 until September 2024, by three repeaters of the Molluscs sample within the four stations, while water and sediment samples were collected by one sample per month to measure heavy element concentrations. Collected samples Molluscs monthly using the method of square quadrat method dimensions 50×50 cm to determine the density of Molluscs was isolated visceral mass of clams using plastic tongs and published on the filter papers to dry in the atmosphere of the laboratory and then placed in the freeze Dryer until dry, then transferred to the dryer until they reach room temperature after that the samples were ground by using ceramic mortar, the samples were then kept in plastic bottles sealed and marked until the process of extracting heavy elements.

Water samples were collected using plastic bottles with a capacity of 2.5 liters from a depth of half a meter, to which some drops of concentrated nitric acid were added until the extraction of heavy elements (Al-Saadi *et al.*,2002). Sediment samples were collected from the river bank after the surface layer was displaced by hand, (Al-Qarouni ,2011).

3- Extraction of heavy elements

The water sample was digested based on the method used APHA (1995). Sediment samples were dried at 60°C for 24 hours and ground with ceramic mortar. Yi *et al.* (2007) method was used to extract ions of heavy elements.

RESULTS AND DISCUSSION

It was found that the highest annual total rates of lead, chromium, cadmium, copper, nickel, arsenic and zinc concentrations in water (25.13, 3.49, 3.42, 13.50, 18.31, 0.13, 22.40) in units of µg/L respectively, while the rates of concentrations in the sediment amounted to (18.22, 7.21, 2.90, 28.43, 57.20, 1.66, 32.27) µg/g respectively, either in the visceral mass of clams *Corbicula fluminea* were concentrations of lead, chromium, cadmium, copper, nickel, arsenic and zinc (90.26, 20.32, 4.93, 32.42, 84.60, 3.15, 90.26) µg/g respectively and in the visceral mass of the clams *Sinanodonta woodiana*. The concentrations were (42.21, 15.12, 3.49, 31.80, 87.41, 2.82, 84.90) µg/g respectively. Environmental factors were also measured during the collection of samples and the highest temperature was recorded during the summer season in the fourth station and amounted to 34°C and the lowest degree was 11 °C during the winter season in the first station as the lowest value of pH was 7.22 and the highest value was 8.41 and the lowest value of dissolved oxygen was 0.64 mg/L in winter and the highest value was in the summer 2.32 mg / liter The biological requirement of oxygen BOD had the lowest value of 0.22 mg /L in the autumn and the highest value of

1.43 mg /L In the spring. The results given in Table (1) showed the concentrations of heavy elements in the water collected from all stations during the study seasons and the highest concentration of zinc was 22.60 ug /L in the third station during the summer season and there were significant differences in some stations during the study seasons and the highest concentration of cadmium was 3.42 µg / L in the fourth station during the summer there were some significant differences during the study seasons and the highest concentration of copper in water was 13.52 µg / L in the third station During the summer season, while the highest concentration of the element lead was 25.13 µg / L , while the element arsenic had the highest concentration in water 0.14 µg / L in the fourth station during the spring season and finally the highest concentration of nickel in the water The third station during the summer season, as it reached 18.31 µg / L.

The results of the study showed that the highest concentration of sediment of the element lead was in the fourth station during the summer season and amounted to 18.22 µg / g and significant differences were observed between all stations during the study seasons The highest concentration of cadmium reached 2.90 µg / g in the fourth station during the summer season, while the copper element had the highest concentration of 28.43 µg / g in the fourth station during the summer season while the highest concentration of zinc reached 32.27 µg / g in the summer season in the third station In the summer season, with significant differences between stations during the seasons of the year, the highest concentration of arsenic element in the sediment was 1.66 µg / g in the third station during the summer season, while the highest concentration of chromium was in the fourth station during the summer season, reaching 7.21 µg / gram, while the nickel era was the highest concentration in the summer season in the third station, as it reached 57.20 µg / g The arrangement of the elements in the sediment was Ni>Zn> Cu> Pb >Cr >Cd >As in Table 2:

In Table No. 3, the results showed the concentration of elements in *C. fluminea* and the highest concentration of lead element was 52.12 µg / l during the summer season in the third station, while the highest concentration of cadmium in the fourth station during the autumn season, as it reached 4.93 µg / l, while the highest concentration of copper element reached 32.42 µg / l in the summer season and was in the third station and the highest concentration of zinc was in the third station during the summer season and amounted to 90.26 µg / liter, the highest concentration of arsenic was 3.15 µg/l in the third phase during the summer season, and the concentration of nickel in the sediment at the station was 84.60 µg/l in the fourth station in the summer season. The results showed the highest concentration of lead in *S. woodiana* was in the third station during the summer season, reaching 42.21 µg/L, the highest concentration of cadmium was 3.49 µg/l in the fourth station during the summer season, while copper reached the highest concentration of 32.80 µg/L in the third station in the summer season, and the highest concentration of zinc reached 84.90 µg/l in the fourth station during the summer season, while arsenic was also the highest concentration in the

station. The fourth was 2.82 µg/l during the summer season, while the highest concentration of chromium was in the third station and reached 15.12 µg/l in the summer season, while the nickel element had the highest concentration at the station 87.41 µg/l in the fourth station during the summer season. Biomarkers are useful for early assessment of pollution (**Cazenave et al. (2024)**), the results of the current study showed seasonal and localized changes in the concentrations of elements in water, sediments and molluscs, and the concentrations of heavy elements took the following order in water Pb>Zn>Ni>Cu>Cd>Cr>As, as lead recorded the highest concentration while chromium and arsenic recorded the lowest concentration of other elements may be due to low industrial activity in these areas, which leads to improved water quality (**Talib et al.,2022**). Arsenic values within the level of natural values may originate in rivers from natural geological materials in the region, but their presence can also be exacerbated by mining operations (**Sun et al. 2021**). The concentrations of elements during the summer season were higher than the rest of the seasons may be due to high temperatures, as high temperatures lead to the release of heavy elements from sediments, especially copper and zinc (**Zhou et al., 2024&Al-Taher et al.,2020**) and low pH levels promote the release of heavy metals such as zinc and copper from the sediments, which increases their biological availability, on the contrary, High pH can stabilize certain metal parts, reducing their movement (**Zhou et al., 2024**)

The results of the current study also showed a high concentration of lead in the Gharraf River that the reason for the high lead element is the presence of water pipes that reach residential areas as well as agricultural activities such as fertilizers and pesticides for agricultural lands located on the banks of the Al-Gharaf River and the results recorded an increase in nickel concentration due to the leakage of residential area waste into rivers, as well as agricultural fertilizers and pesticides and corrosion of pipes of water purification plants on rivers, and this result is consistent with Al-Jasimee, A. S., & Hussein, H. M. (2023). The degree of toxicity depends on the nature of the exchange of chromium with various clay minerals and the way the clams absorbs the vines and that the high deposits of vines form a stress state .The study showed that the highest concentrations of chromium were during the spring and summer. The use of pesticides and chromium-containing fertilizers can transfer vine-runoff to rivers, contributing to pollution levels, (**Tumolo et al. 2020**)

The highest concentration of cadmium was recorded during the summer at 3.42 µg/L Cadmium can enter water systems through atmospheric precipitation, where it settles from the air to water bodies, often as a result of industrial emissions and combustion processes, **Belmeier-Fraser et al. (2016)**. The highest concentration of copper during the summer may be explained by high temperatures, which leads to the dissolution of copper oxides, Or it may be due to chemicals used in the treatment of ammonia-containing water, which helps dissolve copper compounds and thus increase their concentration.(**Palmer et al. 2004**)and (**Al-Ameri, K. H., & Ali, S. 2023**).

Table (1) Concentration of Heavy Elements in Water During Study Seasons

Season	St	Pb		Cd		Cu		Zn		As		Cr		Ni	
		M	SD±	M	SD±	M	SD±	M	SD±	M	SD±	M	SD±	M	SD±
Winter	St1	19.24	±0.45	1.75	±0.50	5.34	±0.38	12.80	±0.89	0.03	±0.002	1.00	±0.17	9.30	±0.32
	St2	15.39	±0.67	1.17	±0.10	2.50	±0.50	9.80	±0.85	0.03	±0.01	1.10	±0.12	6.20	±0.25
	St3	16.64	±0.54	1.80	±0.20	9.23	±0.21	10.30	±0.38	0.04	±0.01	1.97	±0.23	9.38	±0.44
	St4	19.14	±0.87	2.00	±0.55	8.82	±0.44	13.40	±1.43	0.02	±0.001	1.60	±0.18	10.30	±0.96
LSD		0.65		0.56		0.51		1.26		0.06		0.48		0.86	
Spring	St1	22.24	±1.01	1.92	±0.12	7.42	±0.42	18.30	±0.30	0.10	±0.02	1.85	±0.23	11.20	±0.19
	St2	19.95	±0.71	2.11	±0.18	5.21	±0.35	15.62	±0.65	0.08	±0.01	2.00	±0.50	9.00	±0.26
	St3	20.13	±0.95	1.94	±0.32	11.87	±0.20	16.81	±0.80	0.01	±0.001	2.58	±0.11	15.27	±0.31
	St4	21.89	±0.86	2.44	±0.23	11.50	±0.53	18.68	±0.58	0.14	±0.02	2.92	±0.13	13.22	±0.33
LSD		0.55		0.31		0.63		0.69		0.06		0.56		0.35	
Summer	St1	23.18	±1.12	3.06	±0.14	9.41	±0.48	19.40	±1.40	0.11	±0.01	2.20	±0.21	13.21	±0.53
	St2	21.40	±0.97	2.38	±0.20	6.39	±0.34	17.30	±0.30	0.10	±0.03	1.71	±0.22	9.18	±0.29
	St3	22.89	±0.99	2.72	0.47	13.50	±0.54	20.60	±0.60	0.13	±0.04	2.80	±0.32	18.31	±0.90
	St4	25.13	±1.22	3.42	±0.20	12.23	±0.29	22.40	±1.40	0.11	±0.02	3.49	±0.48	16.32	±0.57
LSD		1.54		0.45		0.71		1.58		0.07		0.40		0.88	
Autumn	St1	21.58	±0.42	2.11	±0.10	6.51	±0.47	14.81	±0.99	0.07	±0.02	1.02	±0.10	11.00	±1.03
	St2	20.18	±0.37	1.90	±0.15	4.80	±0.27	11.30	±0.34	0.05	±0.01	1.13	±0.09	7.44	±0.39
	St3	22.78	±0.78	2.62	±0.26	12.07	±0.69	12.40	±1.40	0.06	±0.01	2.10	±0.21	13.40	±0.45
	St4	23.34	±0.67	2.09	±0.50	10.08	±0.82	16.80	±0.87	0.05	±0.001	1.62	±0.20	12.20	±0.87
LSD		0.83		0.42		1.14		1.38		0.08		0.42		0.83	

Table 2: Concentration of heavy elements in sediments during the study seasons

Season	St	Pb		Cd		Cu		Zn		As		Cr		Ni	
		M	SD±	M	SD±	M	SD±	M	SD±	M	SD±	M	SD±	M	SD±
Winter	St1	11.66	±0.87	2.07	±0.08	12.50	±1.45	17.65	±0.62	0.83	±0.18	2.00	±0.12	28.21	±0.20
	St2	10.98	±0.58	1.75	±0.23	11.42	±1.34	11.35	±0.31	0.80	±0.12	1.60	±0.20	20.41	±0.43
	St3	12.67	±0.45	2.06	±0.52	14.23	±1.78	18.35	±0.32	0.93	±0.09	2.42	±0.41	37.14	±0.70
	St4	13.28	±0.76	2.13	±0.14	17.39	±1.56	19.39	±0.42	0.70	±0.15	2.01	±0.31	33.13	±0.27
LSD		0.75		0.27		0.49		0.60		0.09		0.38		2.63	
Spring	St1	13.00	±0.29	1.79	±0.12	17.81	±1.29	24.81	±0.84	1.16	±0.23	4.20	±0.22	28.30	±1.12
	St2	12.78	±0.88	1.84	±0.09	13.50	±1.58	17.24	±0.37	0.97	±0.09	2.82	±0.42	35.13	±0.25
	St3	14.09	±0.76	2.32	±0.26	16.80	±1.64	30.62	±0.63	1.19	±0.20	5.42	±0.53	51.30	±0.23
	St4	14.95	±0.34	2.23	±0.21	20.34	±1.29	25.40	±0.44	1.34	±0.12	4.80	±0.33	47.80	±0.43
LSD		0.83		0.26		0.46		0.84		0.16		0.51		1.34	
Summer	St1	14.54	±0.34	2.35	±0.17	19.20	±1.45	27.42	±1.45	1.24	±0.22	5.32	±0.34	48.20	±0.31
	St2	13.78	±0.67	2.00	±0.08	16.23	±1.57	23.15	±0.89	1.17	±0.18	3.24	±0.10	40.30	±0.47
	St3	15.34	±0.56	2.70	±0.28	18.43	±1.31	32.27	±1.23	1.66	±0.34	6.80	±0.34	57.20	±0.41
	St4	18.22	±1.02	2.90	±0.26	28.43	±1.63	29.38	±0.34	1.43	±0.14	7.21	±0.21	52.30	±0.67
LSD		0.91		0.31		0.31		1.42		0.11		0.32		1.64	
Autumn	St1	13.20	±0.45	2.53	±0.19	15.61	±1.14	19.60	±0.60	0.94	±0.13	3.91	±0.13	39.43	±0.42
	St2	13.08	±0.87	2.19	±0.11	11.90	±1.78	14.80	±0.80	0.82	±0.11	2.23	±0.19	28.33	±1.05
	St3	14.20	±0.56	2.51	±0.53	16.00	±1.36	25.30	±0.37	1.03	±0.31	3.23	±0.20	47.32	±0.30
	St4	15.30	±0.87	2.57	±0.42	19.50	±1.69	22.60	±0.63	0.96	±0.22	3.73	±0.51	40.31	±0.41
LSD		1.12		0.26		0.92		0.91		0.12		0.46		2.98	

Table 3 :Heavy metal concentrations in *C. fluminea* during the study seasons

Season	St	Pb		Cd		Cu		Zn		As		Cr		Ni	
		M	SD±	M	SD±	M	SD±	M	SD±	M	SD±	M	SD±	M	SD±
Winter	St1	42.20	±0.32	2.08	±0.08	19.64	±1.23	50.32	±0.34	1.39	±0.28	5.80	±0.25	50.22	±0.23
	St2	37.89	±0.44	2.45	±0.16	17.41	±1.09	38.41	±1.40	1.22	±0.15	4.32	±0.32	55.30	±0.60
	St3	46.55	±0.89	2.86	±0.11	22.70	±0.79	48.26	±0.22	1.34	±0.11	10.43	±0.13	43.20	±0.29
	St4	44.78	±0.67	1.98	±0.07	19.21	±1.13	45.30	±0.31	1.15	±0.08	8.40	±0.22	48.30	±0.18
LSD		1.67		0.24		0.51		1.12		0.52		0.30		1.12	
Spring	St1	46.17	±1.22	2.43	±0.18	23.81	±1.17	66.20	±0.20	1.36	±0.47	11.13	±0.45	72.20	±0.34
	St2	41.34	±0.97	2.52	±0.52	20.50	±0.78	44.80	±0.82	2.34	±0.34	7.93	±0.13	70.21	±0.28
	St3	49.00	±0.76	3.22	±0.31	28.67	±1.04	88.26	±1.26	2.00	±0.21	19.42	±0.21	80.21	±0.42
	St4	47.86	±0.56	2.84	±0.22	25.45	±0.98	76.26	±1.30	2.38	±0.41	17.00	±0.76	84.22	±0.21
LSD		1.37		0.46		0.38		1.43		0.62		0.81		1.28	
Summer	St1	46.42	±0.34	3.00	±0.87	25.31	±1.09	78.31	±0.32	2.70	±0.11	14.40	±0.21	73.20	±0.67
	St2	43.22	±0.34	3.02	±0.69	23.90	±1.24	48.32	±0.41	2.63	±0.21	10.43	±0.41	70.19	±0.48
	St3	52.12	±0.98	4.11	±0.92	32.42	±0.87	90.26	±1.21	2.78	±0.39	20.32	±0.32	82.32	±0.18
	St4	48.01	±1.01	3.23	±0.86	30.42	±1.23	87.30	±0.31	3.15	±0.41	18.44	±0.65	84.60	±0.65
LSD		2.18		0.19		0.23		1.00		0.35		0.51		1.16	
Autumn	St1	45.33	±0.46	3.20	±0.18	20.74	±0.98	55.60	±0.64	1.61	±0.22	7.30	±0.31	56.20	±0.12
	St2	40.20	±0.22	3.50	±0.53	21.40	±1.34	30.43	±1.45	1.70	±0.11	6.31	±0.11	59.30	±0.42
	St3	49.10	±0.52	3.96	±0.41	26.80	±0.89	60.32	±0.32	1.94	±0.28	14.90	±0.10	68.40	±0.21
	St4	47.50	±0.67	4.93	±0.12	23.65	±1.22	59.32	±0.32	1.39	±0.19	12.45	±0.21	63.28	±0.38
LSD		1.46		0.44		0.37		1.20		0.20		0.29		1.37	

Table 4:Concentration of heavy elements in *S. woodiana* during the study seasons

Season	St	Pb		Cd		Cu		Zn		As		Cr		Ni	
		M	SD±	M	SD±	M	SD±	M	SD±	M	SD±	M	SD±	M	SD±
Winter	St1	32.11	±0.23	1.80	±0.09	18.90	±0.89	42.30	±0.32	1.45	±0.18	5.21	±0.23	44.24	±0.31
	St2	30.21	±0.54	1.51	±0.13	15.64	±1.22	33.41	±1.44	1.23	±0.25	3.31	±0.16	40.13	±0.28
	ST3	34.45	±0.39	2.11	±0.24	19.45	±1.37	55.27	±1.20	1.63	±0.33	9.30	±0.87	52.31	±0.42
	St4	33.45	±0.56	1.85	±0.16	18.50	±1.14	49.31	±0.31	1.43	±0.22	7.43	±0.22	68.32	±0.28
LSD		0.87		0.25		0.51		1.47		0.13		0.34		2.30	
Spring	St1	35.87	±0.56	1.91	±0.05	20.80	±1.75	68.41	±1.48	2.20	±0.10	8.35	±0.32	62.18	±0.67
	St2	32.01	±0.71	1.97	±0.09	18.60	±1.49	42.32	±0.48	2.15	±0.08	7.21	±0.27	59.32	±0.75
	ST3	39.77	±0.89	2.27	±0.49	25.62	±1.02	75.62	±0.67	2.32	±0.14	13.21	±0.45	73.21	±0.54
	St4	38.56	±0.87	2.53	±0.17	22.43	±1.68	69.84	±0.94	2.45	±0.23	10.43	±0.65	83.92	±0.93
LSD		1.08		0.46		0.71		1.33		0.11		0.35		1.88	
Summer	St1	39.09	±0.89	2.62	±0.48	23.90	±1.38	70.32	±0.32	2.80	±0.13	12.40	±0.13	71.13	±0.42
	St2	36.45	±0.79	2.26	±0.31	20.14	±1.45	45.22	±0.71	2.35	±0.09	9.13	±0.13	60.23	±0.37
	ST3	42.21	±0.67	3.10	±0.53	31.80	±1.57	80.33	±1.30	2.54	±0.22	15.12	±0.32	80.30	±0.64
	St4	40.19	±0.92	3.49	±0.12	28.90	±1.76	84.90	±0.91	2.82	±0.14	13.62	±0.64	87.41	±0.62
LSD		1.87		0.34		0.48		1.24		0.17		0.57		1.25	
Autumn	St1	34.56	±0.73	2.42	±0.29	19.76	±1.45	53.26	±0.31	1.86	±0.13	8.00	±1.07	60.32	±0.20
	St2	32.14	±0.45	2.39	±0.37	16.40	±1.06	40.00	±1.02	1.52	±0.09	5.30	±0.76	54.31	±0.64
	ST3	39.33	±0.67	2.93	±0.30	23.42	±1.39	65.32	±0.31	2.01	±0.11	10.80	±0.21	62.15	±0.25

	St4	37.22	±0.89	2.82	±0.27	20.82	±1.59	58.32	±0.37	1.92	±0.31	9.00	±0.87	76.21	±0.20
LSD		1.24		0.39		0.32		0.86		0.08		0.28		1.27	

CONCLUSION

The results proved the presence of high concentrations of lead, nickel, zinc, copper and chromium in the Gharraf River in southern Iraq, which requires monitoring and taking possible measures to control the hydration with heavy elements.

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