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Bioaccumulation of some heavy metals in some organs of common carp (*Cyprinus carpio*) fish captured from Darbandikhan Lake Sirwan and Tanjaro river

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Abstract

This study was done in three stations the Darbandikhan dam with GPS Coordination of this station 35°7'16''N (Latitude) 45°43'18'' E (Longitude), Sirwan River located in 35°7'17''N; 45°50'54'' E and Tanjaro River Side with GPS Coordination of Tanjaro River Site sample location details 35°14'22''N; 45°51'58'' E to study the heavy metals contamination in water and selected organs of carp lived in these three locations and for six months. The studied heavy metals include Hg, Cd, Pb, Cu, Co and Cr analyzed by ICP-OES (Spectro acros). The bioaccumulation levels of heavy metals by passing time in the liver of the fishes is significant P≤0.05 for all the studied heavy metals. Hg was higher significantly P≤0.05 in November 2021 and January 2022. Cd in October 2021. Pb in October 2021. Cu in September 2021. Co in September 2021. The Hg concentrations in common carp liver were higher significantly P≤0.05 in Sirwan station, the Co and Cu were higher significantly P≤0.05 in Darbandikhan dam fish, the Pb and Cd were higher in Sirwan and Tanjaro fish liver. In most months the bioaccumulation of Hg in fish gills is below the detectable level except for November 2021 which was higher and January 2022 which was lower significantly. Cd was significantly P≤0.05 higher in August 2021, the Pb in each of September and October 2021. The Cu was higher in November 2021, and the Co in October 2021. Pb was higher significantly P≤0.05 in each Sirwan and Tanjaro. Cu increased significantly P≤0.05 in Sirwan and Darbandikhan dams. Due to the annual mortality of fish in Darbandikhan, Sirwan and Tanjaro river the present research done in order to detect the

main reasons of water pollution with some heavy metals and its relation to fish mortality and detect the levels of some heavy metals in some fish organs.

Keywords: heavy metals, liver, gill, common carp.

Introduction

Water plays a major role in any nation's political and economic sectors, which include agriculture, livestock farming, forestry management, the industry that produces power, fisheries, and other creative activities, which all contribute significantly to the development of that area (1). A lake is a sizable body of water surrounded by land and teeming with various aquatic species, including fish. In addition to the influx of wastewater effluent, salting, home sewage, and other factors have all contributed to the degradation of a lake's water quality (2). In the Kurdistan region, the main sources of water for life activities are surface water such as rivers, dams (Artificial Lakes), ponds, springs, and groundwater such as hand-dug wells. The quantity and quality of the water sources vary depending on the environment, including the parent rocks' chemical makeup, the amount of precipitation, how the soil formed, and how long the water was trapped below (3). Lake pollution in the Kurdistan region is a very serious and vital problem because of the huge quantity of contaminants emitted by urban activities. Lake nutrient enrichment is one of the main environmental concerns in several countries as well as the Kurdistan region. Heavy metals have a wider environmental distribution, a propensity to concentrate in certain living organism tissues, and the potential to be hazardous even at low exposure levels. Heavy metals have a wider environmental distribution, a propensity to concentrate in certain living organism tissues, and the potential to be hazardous even at low exposure levels (4). They are hazardous at large concentrations because they accumulate more quickly in living things like fish than they do when they are broken down. Since fish are frequently at the top of the aquatic food chain and may, therefore, concentrate high amounts of some heavy metals from the water, eating fish can be a significant way for humans to become exposed to a several of heavy metals, including mercury, lead, cadmium, and copper (4).

Fish are an important source of protein in aquatic ecosystems. However, the level of pollution has also been increasing in aquatic ecosystems and this is threatening human health through the food chain. As a result of the pollution in aquatic habitats, environmental balance is destroyed, and significant problems emerge sociologically and economically, accumulation in fish tissues in contaminated waters pointed out that considerable levels of toxic metals may be accumulated in fish including edible tissues without causing mortality (5). Darbandikahan Lake, it locates 60 km southeast of Sulaymaniyah city. The supply source of the lake is two branches feeding the lake which is the Tanjaro River and the Sirwan River beside another supply source of precipitation such as rain, snow and round waters from springs around the lake.

Darbandikhan lake is important for the life of people living in the area around as it is the main source of drinking and irrigation water and the lake is rich with aquatic species so considered a rich source for fishers, it is also an important source of electrical power generation through Darbandikhan dam, and its beauty make it a recreational destination area (6). The purpose of this study is to measure the accumulation level of heavy metals (Hg, Cd, Pb, Cu, Co, and Cr) in fish species (*C. carpio*) and water sources collected from Darbandikhan Lake. The study was necessary as a large number of people consume the Carp fish in this area, but there is no literature report on the levels of heavy metal concentrations in water, Carp fish in which can be used to show the extent of the problems in this lake. And focuses on the levels of Hg, Cd, Pb, Cu, Co and Cr, which are especially known as toxic, and the levels of Hg, Cd, Pb, Cu, Co and Cr that can cause toxicity when taken in a high amount in the gills, and livers of Common carp (*C. carpio*).

Methods and Materials

Darbandikahan Lake, it locates 60km southeast of Sulaymaniyah city. The supply source of the lake is two branches feeding the lake which is the Tanjaro River and the Sirwan River beside other supply sources of precipitation such as rain, snow, and ground waters from springs around the lake (7). The Darbandikhan lake is located at 35° 6′ 35″ N longitude, 45° 41′ 20″ E latitude and the altitude is 485 m, about 60 km southeast of Sulaymaniyah City in the Kurdistan Region, northern Iraq (6).

One of the main risks to public health in the Kurdistan region of Iraq is water contamination. The city of Sulaymaniyah is located at an elevation of 880 m in the region of Kurdistan in north-eastern Iraq and has a population of approximately more than 1.5 million inhabitants (7). One of the primary water sources that supply water to virtually the whole Sulaymaniyah province is Darbandikhan Lake. This examination was done to determine the safety of drinking water and fish from the lake for heavy metals after many televisions report alarms on the poisoning of drinking water in Darbandikhan. The investigation encompassed sample analysis from the lake including reservoir water, tank water and tap water on a monthly basis for one year to monitor the heavy metal (Pb, Cd, Zn, and Cu) accumulation. Additionally, to evaluate the toxicity of heavy metals to young fish (ages 1-3) in these lakes and to compare the cumulative effects of the contaminated aquatic environment on the fish.

The Tanjaro River, which enters from the North/Northwest, and the Sirwan River, which enters from the East, are its two principal tributaries (from Iran). Currently, the degradation of Darbandikhan Lake by sewage and municipal trash puts it in grave danger. preliminary findings from heavy metal testing at Darbandikhan Lake's several locations, with comparisons to other surface waters (7).

Hundreds of small and some large industrial areas have been established around the river, and the river flows to Darbandikhan Lake, contaminating it as well, as shown in figure 1. Additionally, the solid waste from

Sulaymaniyah is dumped without treatment close to the same river and the city sewerage from Sulaymaniyah flows down to the Tanjaro River south of the city.

Darbandikhan Dam area: The part of the lake which is located behind the dam directly with 40-50m depth as average in the area, table number one shows the location details of a sample taken from the area during the six months of our study.

GPS Coordination of this station 35°7’16’’N (Latitude) 45°43’18’’ E (Longitude).

Sirwan River : The area where the Sirwan river reaches the lake , the area which is rich with fishes and a source of life for many fishermen not only from Darbandikhan but also coming from Halabja city for fishing , the level of the water in this area depends on how much water follows from Iran throw Sirwan river which will decrease especially during summer time as there is no feed from Iran to the river site this issue was preventing us to rich the same area again by passing time the Sampling location details are 35°7’17’’N; 45°50’54’’ E.

The Tanjaro River Side: The majority of Sulaymaniyah’s city waste is dumped straight into the Tanjaro River in the Tanjaro area. This waste is made up of domestic, industrial, transportation, mining, and agricultural wastes. This caused the majority of the toxins and pollutants to leak into the river this river then runs by/through different Governorate regions, combining with other rivers or tributaries, until finally emptying into Darbandikhan Lake.

GPS Coordination of Tanjaro River Site sample location details 35°14’22’’N; 45°51’58’’ E.

The heavy metal content was analyzed using an ICP-OES (spectro acros) multi-element system, which is powered by Argon gas and nebulizer gas flow (l/min). At 14–16 Co, ICP-OES analysis begins with three samples replicate.Fish sampling: Fish was acquired on-site from local fishermen and sampled there with their assistance using a fishing net. The length was between 20 cm and 30 cm to reduce the difference in the metal buildup.Extraction of heavy metals from fish: According to the Food and Agriculture Organization of the United Nations, fish specimens were dissected to reveal individual organs (gills, and the entire liver) (8). Organs were kept frozen at -20°C after weighing dissection. To achieve constant weight, samples were dried at 105°C in an oven after being thawed at room temperature and placed in Petri plates containing around 1gm of these native organs. After that burned in a Muffle furnace at 550oC till the weight is constant (9). Hg, Cd, Pb, Cu, Co and Cr were analyzed by ICP-OES (Spectro across) to determine the metals depending on the metal concentration.

Results

Table (1) Shows the differences in heavy metal bioaccumulation by passing time in the liver of the fish which is significant for all the studied heavy metals. Hg was higher significantly $P \leq 0.05$ in November 2021 and January 2022. Cd in October 2021. Pb in October 2021. Cu in September 2021. Co in September 2021.

The Hg concentrations in common carp liver were higher significantly in Sirwan station, the Co and Cu were higher significantly in Darbandikhan dam fish, the Pb and Cd were higher in Sirwan and Tanjaro fish liver as shown in table (2). According to the interaction table (3), the Hg concentration was higher in November-2021/ Sirwan while in most areas and times were below the detectable level. The higher level of Cd was in October-2021/ Tanjaro while the lowest was in January-2022/ Tanjaro. The Pb was higher in October-2021/ Tanjaro while for other months it was below the detectable level. The Cu was higher level in November-2021/ Sirwan. The Co was higher in September-2021/ Darbandikhan. In most months the Concentration of Hg in Fish Gills is below the detectable level as shown in Table (4) except for November 2021 which was higher and January 2022 which was lower significantly. Cd was significantly higher in August 2021, the Pb in each of September and October 2021. The Cu was higher in November 2021, and the Co in October 2021. No significant differences $p \geq 0.05$ seen in the levels of Hg, Cd and Co among the stations. Pb was higher significantly in each Sirwan and Tanjaro. Cu increased significantly in Sirwan and Darbandikhan dam as observed in the table (5). Table (6) explain the interaction between studied station and the different months for each studied metal in fish gills in which Hg was detected in just three times among stations and times in November-2021/ Sirwan, November-2021/ Darbandikhan and January-2022/ Sirwan. The Cd was higher significantly in August-2021/ Tanjaro, Pb in September-2021/ Tanjaro and October-2021/ Sirwan. Cu in November-2021/ Sirwan. And Co in October-2021/ Sirwan. Hg was detected only in Sirwan, Cu was higher in Sirwan, CO in each of Tanjaro and Darbandikhan. No significant differences were observed in each Cd and Pb as seen in the table (8). According to the interactions between studied location and months the Hg was detected only in November-2021/ Sirwan, November-2021/ Darbandikhan, December-2021/ Tanjaro and January-2022/ Sirwan. Cd was significantly higher in August-2021/ Tanjaro. Pb in August-2021/ Tanjaro, September-2021/ Sirwan, October-2021/ Darbandikhan, and after that it was below the detectable level. Cu in November-2021/ Sirwan. Co in October-2021/ Tanjaro. As shown in table (9).

Table 1: Heavy metal bioaccumulation (ppb) in the fish liver in the studied months (From 8, 2021 till 1, 2022) in ppb.

Months	Hg	Cd	Pb	Cu	Co	Cr
August 2021	1.00 b	93.21b	50.19b	17013d	1061.51 d	BDL
September 2021	0.99 b	99.93b	38.35b	380237a	10741.31 a	BDL
October 2021	1.17 b	281.66a	514a	50502c	5520.84 b	BDL
November2021	2.35 a	7.84c	BDL	75434b	3145.96 c	BDL
December 2021	0.99 b	14.08c	BDL	40310b	2735.25 c	BDL
January 2022	1.97 a	3.41c	BDL	16267d	184.32 d	BDL

BDL: Below Detected Level; Different letters indicate a significant difference P≤0.05

Table 2: Heavy metal bioaccumulation in fish liver in ppb in the studied station (Sirwan, Tanjaro and Darbandikhan dam)

Location	Hg	Cd	Pb	Cu	Co	Cr
Sirwan	1.85 a	101.93 a	40.87 ab	50621.89 b	2538.52 b	BDL
Tanjaro	1.09 b	98.00 a	248.07 a	29912.74 c	3315.49 b	BDL
Darbandixan	1.30 b	50.13 b	13.84 b	209346.97 a	5840.59 a	BDL

Table 3: Shows the Heavy metal accumulation in the fish liver in ppb according to the interaction between the studied location and studied months

Month / location	Hg	Cd	Pb	Cu	Co	Cr
August-2021/ Sirwan	BDL	98.15	71.55	19010.76	1487.86	BDL
August-2021/ Tanjaro	BDL	114.06	BDL	15541.91	1138.38	BDL
August-2021/ Darbandikhan	BDL	67.41	78.08	16485.55	558.29	BDL
September-2021/ Sirwan	BDL	276.34	72.76	83252.68	1663.62	BDL
September-2021/ Tanjaro	BDL	15.34	41.28	38699	6267.75	BDL
September-2021/ Darbandikhan	BDL	8.11	BDL	101875	24292.55	BDL
October-2021/ Sirwan	BDL	198.86	97.90	14933.51	4284.37	BDL
October-2021/ Tanjaro	BDL	435.48	1443.16	30697.59	4987.95	BDL
October-2021/ Darbandikhan	BDL	210.65	BDL	105874.93	7290.21	BDL

November-2021/ Sirwan	5.04	10.84	BDL	140737.65	2651.53	BDL
November-2021/ Tanjaro	BDL	7.45	BDL	45428.27	5770.56	BDL
November-2021/ Darbandikhan	BDL	5.24	BDL	40136.61	1015.79	BDL
December-2021/ Sirwan	BDL	21.53	BDL	22659.54	4768.38	BDL
December-2021/ Tanjaro	1.52	14.35	BDL	35812.44	1661.93	BDL
December-2021/ Darbandikhan	BDL	13.19	BDL	62459	1775.45	BDL
January-2022/ Sirwan	2.10	5.88	BDL	23137.20	375.33	BDL
January-2022/ Tanjaro	BDL	1.32	BDL	13297.24	111.24	BDL
January-2022/ Darbandikhan	2.82	3.04	BDL	12366.47	66.38	BDL

Different letters indicate a significant difference P≤0.05

Table 4: Heavy metals accumulation in Fish Gills in ppb During the Study Period from August 2021 till January 2022.

Months	**Hg**	**Cd**	**Pb**	**Cu**	**Co**	**Cr**
August 2021	BDL	94.35 a	31.33 b	12568.05 b	354.24 c	BDL
September 2021	BDL	13.83 b	258.84 a	4866.53 d	772.86 b	BDL
October 2021	BDL	25.66 b	244.61 a	7574.30 cd	1404.89 a	BDL
November2021	1.33 a	6.55 b	BDL	29325.86 a	604.35 b	BDL
December 2021	BDL	6.24 b	BDL	7850.55 cd	576.70 bc	BDL
January 2022	1.14 b	2.76 b	BDL	10657.50 bc	104.19 d	BDL

Different letters indicate a significant difference P≤0.05

Table 5: Heavy Metal Concentration in Fish Gills in ppb in the Studied Locations (Sirwan, Tanjaro and Darbandikhan dam).

Months	**Hg**	**Cd**	**Pb**	**Cu**	**Co**	**Cr**
Sirwan	1.15 a	12.93 a	127.05 a	15035.45 a	672.99 a	BDL
Tanjaro	BDL	36.51 a	95.80 a	7557.14 b	537.90 a	BDL
Darbandikhan	1.08 ab	25.26 a	46.03 b	13828.80 a	697.71 a	BDL

Different letters indicate a significant difference P≤0.05

Table 6: Heavy Metal Concentration in Fish Gills in ppb in the interaction between the studied locations and studied months

Month / location	Hg	Cd	Pb	Cu	Co	Cr
August-2021/ Sirwan	BDL	7.39 b	20.68 d	5036.08 cd	169.11 fg	BDL
August-2021/ Tanjaro	BDL	192.74 a	72.29 cd	7372.70 cd	442.76 efg	BDL
August-2021/ Darbandikhan	BDL	82.92 b	BDL	25295.36 b	450.85 efg	BDL
September-2021/ Sirwan	BDL	BDL	313.67 b	4418.38 d	325.38 efg	BDL
September-2021/ Tanjaro	BDL	7.85 b	337.66 ab	4128.99 d	527.85 ef	BDL
September-2021/ Darbandikhan	BDL	32.65 b	125.19 c	6052.22 cd	1465.35 b	BDL
October-2021/ Sirwan	BDL	50.90 b	424.97 a	6888.95 cd	2003.75 a	BDL
October-2021/ Tanjaro	BDL	6.53 b	161.85 c	6554.74 cd	1185.53 bc	BDL
October-2021/ Darbandikhan	BDL	19.55 b	147.01 c	9279.22 cd	1025.38 cd	BDL
November-2021/ Sirwan	1.50a	7.38 b	BDL	53793.75 a	771.24 cde	BDL
November-2021/ Tanjaro	BDL	4.50 b	BDL	5146.33 cd	317.87 efg	BDL
November-2021/ Darbandikhan	1.51a	7.76 b	BDL	29037.49 b	723.93 de	BDL
December-2021/ Sirwan	BDL	6.88 b	BDL	7425.83 cd	566.91 ef	BDL
December-2021/ Tanjaro	BDL	5.78 b	BDL	7425.83 cd	698.08 de	BDL
December-2021/ Darbandikhan	BDL	6.06 b	BDL	5183.26 cd	465.09 efg	BDL
January-2022/ Sirwan	1.42a	4.03 b	BDL	12649.71 c	201.58 fg	BDL
January-2022/ Tanjaro	BDL	1.63 b	BDL	11197.55	55.31 g	BDL

				cd		
January-2022/ Darbandikhan	BDL	2.62 b	BDL	8125.24 cd	55.67 g	BDL

Different letters indicate a significant difference P≤0.05

Table 7: Accumulation of Studied heavy metals in ppb in fish meat during the Study Period from August 2021 till January 2022.

Months	**Hg**	**Cd**	**Pb**	**Cu**	**Co**	**Cr**
August 2021	BDL	115.00 a	160.31 a	15842.56 b	110.12 c	BDL
September 2021	BDL	27.96 b	193.98 a	8522.84 c	919.67 b	BDL
October 2021	BDL	36.92 b	111.71 ab	15465.05 b	1409.03 a	BDL
November2021	BDL	6.21 b	BDL	34931.88 a	306.65 c	BDL
December 2021	BDL	4.15 b	BDL	6768.53 c	207.19 c	BDL
January 2022	**BDL**	**3.40 b**	**BDL**	**9553.83 c**	**68.88 c**	**BDL**

Different letters indicate a significant difference P≤0.05

Table 8: Accumulation of the studied heavy metals in ppb in fish meat in the studied locations

Study Locations	**Hg**	**Cd**	**Pb**	**Cu**	**Co**	**Cr**
Sirwan	2.52 a	26.87 a	100.08 a	19523.55 a	335.65 b	BDL
Tanjaro	BDL	54.11 a	63.81 a	13774.49 b	626.26 a	BDL
Darbandixan	BDL	15.83 a	70.61 a	12244.30 b	548.86 a	BDL

Different letters indicate a significant difference P≤0.05

Table 9: The accumulation of Studied heavy metals in the Studied Locations during the study period in ppb.

Month / location	**Hg**	**Cd**	**Pb**	**Cu**	**Co**	**Cr**
August-2021/ Sirwan	BDL	87.39 b	13.72 c	19546.09 bc	291.66 de	BDL
August-2021/ Tanjaro	BDL	251.89 a	368.82 a	14802.12 bcd	BDL	BDL
August-2021/ Darbandikhan	BDL	5.71 b	98.39 bc	13179.47 cde	37.71 e	BDL
September-2021/ Sirwan	BDL	3.30 b	554.22 a	6093.83 def	280.11 de	BDL
September-2021/ Tanjaro	BDL	55.41 b	5.97 c	15521.27 bcd	1344.21 b	BDL

September-2021/ Darbandikhan	BDL	25.16 b	21.75 c	3953.42 ef	1134.68 bc	BDL
October-2021/ Sirwan	BDL	55.34 b	29.53 c	10754.13 cdef	784.53 cd	BDL
October-2021/ Tanjaro	BDL	2.36 b	5.09 c	15224.34 bcd	1926.75 a	BDL
October-2021/ Darbandikhan	BDL	53.04 b	300.52 ab	20416.67 bc	1515.82 ab	BDL
November-2021/ Sirwan	1.48b	7.66 b	BDL	67158.16 a	291.81 de	BDL
November-2021/ Tanjaro	BDL	5.73 b	BDL	13950.18 cd	229.33 de	BDL
November-2021/ Darbandikhan	1.51a	5.25 b	BDL	23687.28 b	398.81 de	BDL
December-2021/ Sirwan	BDL	2.88 b	BDL	2449.76 f	231.80 de	BDL
December-2021/ Tanjaro	1.26b	6.14 b	BDL	14693.10 bcd	238.00 de	BDL
December-2021/ Darbandikhan	BDL	3.44 b	BDL	3162.73 f	151.77 e	BDL
January-2022/ Sirwan	9.61a	4.68 b	BDL	11139.31 cdef	134.01 e	BDL
January-2022/ Tanjaro	BDL	3.15 b	BDL	8455.92 def	18.24 e	BDL
January-2022/ Darbandikhan	BDL	2.36 b	BDL	9066.26 def	54.39 e	BDL

Different letters indicate a significant difference P≤0.05

Discussion

The Sulaymaniyah city sewerage flows down to the Tanjaro River south of the city also the solid waste is dumped without treatment near the same river alongside. The river is surrounded by hundreds of tiny and some big industrial districts, and because the river runs into Darbandikhan Lake and contaminates it, the results showed that pollution occurred in the various locations and months mentioned above. These findings make sense given that some preliminary data from the University of Sulaymaniyah suggested that high levels of lead (Pb) and mercury (Hg) were the primary contributors to fish death. Dr. Abdul Hameed, a water quality specialist from the University of Baghdad, pointed out that these places contain abnormal concentrations of lead, which would typically come from external sources like a factory or factories upstream, after discussing the Nature Iraq results for heavy metals (personal communication). The findings do suggest that fish in the Tanjaro River/Darbandikhan Lake basin may be exposed to cadmium, lead, manganese, zinc, and nickel over an extended period, and that these levels may be high enough to pose substantial health hazards to people and another biota who eat these fish (10).

South of the city, the Tanjaro River receives the wastewater from the city. The untreated solid trash is dumped close to the same river and partially covered with soil. Around the river, hundreds of tiny and some major industrial districts have been built, and the river runs into Darbandikhan Lake, contaminating it as well. Historically, there was just one industrial region southwest of the city, but the post-2003 economic boom resulted in a significant increase in small and medium-sized industrial projects,

leading to the creation of a new area for similar operations south of the city near the Tanjaro River. Environmental health research is still underdeveloped in the area despite its significance. Studies on the city's water pollution and the effects of Sulaymaniyah wastewater on the tainting of the water and soil around and in the Tanjaro River have been conducted, and they have revealed significant concentrations of several heavy metals in soil and water samples (11). Additionally, allegations of Darbandikhan Lake contamination point to a significant concentration of heavy metals in the lake's water (10); this is all supported by the findings of the most current study. Numerous physical, chemical, and biological substances can be harmful to human health, whether they are produced naturally or as a result of human activity. Untreated wastewater, contaminated agricultural fields, untreated solid waste, industrial waste, and contamination of the Tanjaro River and Darbandikhan Lake from these sources of pollution are only a few of the issues that contribute to environmental pollution in and around Sulaymaniyah city. Populations are in danger of both short-term and long-term consequences of biological, physical, and chemical contaminants, particularly south of the city and in the vicinity of Tanjaro River and Darbandikhan Lake. This is especially true for individuals who live closest to the aforementioned pollution sources. This explanation may be the cause of the various concentrations of heavy metals in the analyzed region over these months. Neglecting these issues will result in the continued buildup of pollutants in the environment and risk to population health (12). There are several sources of pollution in the Tanjaro River. Much of the sewage comes from the Sulaymaniyah City center. This includes: raw influent (sewage), which comes from household waste liquid such as toilets, baths, showers, kitchens, sinks, etc. disposed via sewers, and municipal wastewater, which originates as residential, commercial, and industrial liquid waste and includes stormwater runoff. In addition, the Tanjaro River was polluted by sewage sources (10) originating from Qalawa, Qiliasan, Wluba, Bakrajo, Kani Goma, Shekh Abbas, Tanjaro villages, and both legal and illegal factories located on the Tanjaro River. Other potential sources of contamination are runoff from excess irrigation on fields that have been applied to pesticides and fertilizers and leachate from the Tanjaro landfill (13) and all of these may cause the results of the recent study. The findings of the present study are consistent with the findings of the results of the study (14), which showed that the concentrations of cobalt, chromium, copper, iron, and zinc in the Tanjaro River were all below the allowable limits. However, cadmium, lead, and nickel were above the WHO-permitted limits because of the impact of sewage and industrial wastewater that directly discharge into the river. As demonstrated in numerous fish species like *C. carpio* and *Tinca tinca* from lake Beysehir Turkey, target organs including the gills and intestine are metabolically active sections that can accumulate heavy metals in higher amounts (15), in *Oreochromis mossambicus* and *Clarias gariepinu*s from Olifant River, South Africa. Due to the relatively high propensity for metal accumulation, the metal

may be found in large amounts in the gill and digestive gland (15) reported that the organ of tissue in the accumulation of heavy metals is not active. It is evident that compared to muscles, gills and liver have a higher potential to accumulate heavy metals. The concentrations of heavy metals in the fish under study varied greatly depending on the metal, organ, and species., this is in agreement with that reported by (16). The liver and gills, had the highest metal accumulation, according to the findings, whereas the muscle tended to acquire less metal. For the fish's edible components, the metal content of the muscle tissue is crucial. Additionally, the levels of heavy metals in the water were lower than those in the tissues of the fish, which may be the result of bio-accumulation (17) also revealed that fish had higher metal concentrations than the water did, indicating bioaccumulation.

The levels of metals in a fish's gill correspond to the levels of metals in its habitat, whilst the levels in the liver indicate that the metals are being stored there (18). Thus, more often than any other fish organs, the liver and gill are recommended as environmental indicators of water pollution. This is possibly explained by the tendency of the liver and gill to accumulate pollutants at varying levels from their environment, as has been previously documented in the literature (19).

In filtered water, the mean concentrations of all heavy metals (Cd, Zn, Ni, Cr, Cu, and Pb) were below the detection limit (1 g/L), according to study data (20) except of Zn, which was 8.18 g/L. Whereas, the mean concentrations of heavy metals (Cd, Zn, Ni, Cr, Cu and Pb) in sediments were 6.90 µg/L, 146.29 µg/L, 151.46 µg/L, 161.74 µg/L, 38.86 µg/L and 92.49 µg/L, respectively. And showed that storing of heavy metals occurs by this order; Zn>Cu>Ni>Cr>Cd>Pb and the trend of heavy metals concentrations in various organs of the fish represented as follows: liver> gills> muscles> skin> intestine, for Cadmium, intestine> gills> liver> skin> muscles, for Zinc, skin> intestine> liver> gills> muscles, for Nickel, gills> muscles> intestine> skin> liver, for Chromium, liver> intestine> skin> gills> muscles, for Copper gills> muscles> liver> skin> intestine, for Lead.

Canli (21) arranged the metal concentrations in fish as follows: Zn is followed by Cu and then Cd. Hama, (22) discovered that the four heavy metal concentrations in common benthic fishes decreased in the following order: Zn > Cu > Cd = Pb. (23) outlined the following order for the average metal concentrations in fish tissues from Lake Manzala, Egypt: Zn>Cu>Pb>Cd. High levels of Zn and Cu in hepatic tissues are typically tied to a natural binding protein like metallothionein (MT) (24) that serves as essential metal storage, suggesting that the accumulation of critical metals in the liver is related to its function in metabolism (i.e., Zn and Cu). Due to increased amounts of heavy metals, which bind to the metal to detoxify it, these low molecular weight proteins are produced in greater quantities, which concentrates and controls metals in the liver. The concentration of Pb in the fish gills was found 11.443 µg/L. The levels were higher than the WHO recommended limit for fish and fish products of 2000 µg/L (25), and the

other organs undetectable or the values were below 1µg/L.

Conclusion

According to the results of the recent study the below was concluded: Hg (Detected all months in the liver; BDL in most Gill and in all meat samples BDL. Cd was arranged in Liver (83.355) > Meat (32.27) > Gill (24.898). Pb (Last three months BDL; Nov, Dec, Jan), in the arrangement Liver (200.85) > Gill (178.26) > Meat (155.33). Cu Liver (96627.1667 > Meat (15180.782) > Gill (12140.465). Co in Liver (3898.198) > Gill (636.205) > Meat (503.59). and according to the studied station the arrangement changed as: Hg According to stations Liver (1.413), Gill (in Tanjaro BDL 1.115), Meat in Darbandikhan and Tanjaro BDL Just 2.52 in Sirwan. Cd in Liver (83.35) > Meat (32.27) > Gill (24.9). Pb in Liver (100.93) > Gill (89.63) > Meat (78.17). Cu in Liver (96627.2) > Meat (15180.78) > Gill (12140.46). Co in Liver (3898.2) > Gill (636.2) >Meat (503.59).

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Conflict of interest

There is no conflict of interest.

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تقييم حالة بعض العناصر الثقيلة في بعض اعضاء سمكة الكارب العادي المصادة من بحيرة دربنديخان ونهرا سيروان وتانجرو

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الخلاصة

تم اجراء الدراسة الحالية فى ثلاث محطات بحيرة دربنديخان باستخدام GPSعلى 16’7°35 (Latitude) N ’’ ونهر تانجرو عند 45°43’18’’ E (Longitude)ونهر سيروأن الواقع عند 17’7°35 E ’’50’54°45 ;N ’’لدراسة تلوث المياه وبعض أعضاء جسم الأسماك ببعض العناصر الثقيلة ولمدة ثلاثة أشهر. 22’14°35 ’’51’58°45 ;N ’’ تم دراسة العناصر الزئبق والكادميوم والرصاص والنحاس والكوبلت والكروم باستخدام جهاز ICP-OES (Spectro across).لوحظ اختلاف وتراكم للعناصر الثقيلة بمرور الوقت فى كبد الأسماك والتى كانت مرتفعة معنويا. كان Hgاعلى معنويا فى كانون الأول والثاني ٢٠٢١ و٢٠٢٢ على التوالي. الكادميوم والرصاص فى تشربن الثاني ٢٠٢١ Cu .و Co فى ايلول ٢٠٢١. كان تركيز الزئبق فى كبد الكارب اعلى معنويا فى محطة سيروان. وكان الكوبلت والنحاس اعلى معنويا فى بحيرة دربنديخان، وكان الرصاص والكادميوم اعلى فى كبد اسماك نهرا سيروان وتانجرو. كان تركيز الرصاص فى اغلب أشهر الدراسة اقل من الحد الأدنى للقراءة ماعدا لشهر كانون الأول. كان الكادميوم اعلى معنويا فى اب ٢٠٢١. وكان الرصاص اعلى معنويا فى ايلول وتشرين الثاني ٢٠٢١. اما النحاس فقد كان اعلى معنويا فى تشرين الثاني ٢٠٢١ والكوبلت هو الاعلى فى تشربن الأول ٢٠٢١. وكان الرصاص اعلى معنويا في نهري سيروان ودربنديخان. وكان النحاس اعلى معنويا

فى نهر سيروان وسد دربنديخان. نتيجة لحالات النفوق السنوية التى تحدث فى دربنديخان ونهري سيروان وتانجرو أجريت هذه الدراسة وذلك لغرض تحديد الاسباب الرئيسة لتلوث المياه بالعناصر الثقيلة وعلاقتها بهلاكات الأسماك وتحديد مستويات بعض العناصر الثقيلة فى بعض اعضاء الاسماك.

الكلمات المفتاحية: العناصر الثقيلة، الكبد، الغلاصم، اللحم، الكارب العادي،