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Study of some toxic metals in parts from catfish (*Silurus triostegus*) in Shatt Al-Arab River

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Abstract

According to their toxicity, toxic heavy metals such as arsenic, mercury, cadmium, copper, zinc, and lead are believed to be the most harmful to humans, fish, and the environment. Because their levels are rising due to human activities endangering aquatic species and people, the current study sought to ascertain the level of toxic heavy metals in five catfish parts (skin, liver, muscles, gills, and ovaries). In the northern part of the Shatt Al-Arab, catfish samples were collected in March 2022. ICP-MS was used to detect target metal levels. According to the results, arsenic accumulated in the skin and muscles at a rate of 0.22 and 0.21ppm, respectively. In contrast, the levels of arsenic in the various body parts are not statistically different. Additionally, cadmium showed no noticeable variances in the studied body parts. Furthermore, the liver had the most significant copper accumulation 18.72ppm. Furthermore, mercury accumulation in various body parts was shown to vary statistically, with the highest levels in muscles 0.66ppm. In addition, zinc was accumulated in the body parts in the following sequence: gills, ovaries, liver, skin, and muscles, respectively, while in the following sequence: muscles, skin, gills, liver, and ovaries respectively in the lead. Moreover, there were no statistically significant differences in the quantity of zirconium that accumulated. According to the current study, the catfish's body parts did not accumulate toxic heavy metals at high rates. This may be due to study area the environment and the mechanisms of treating these types of metals by catfish.

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Introduction

The Euphrates and Tigris rivers meet near Qurna city in the Basrah region of southern Iraq to form the Shatt Al-Arab River, which empties into the Arabian Gulf. For the province of Basrah and several Iranian cities, the Shatt Al-Arab River serves as an international boundary between Iraq and Iran. The river is regarded as a navigation corridor for shipping, oil transportation, and fishing, in addition to being used by people for various of activities that use its water (1). On both river banks, several ports primarily base their operations on tidal conditions (2,3). With a mixed fauna of low endemicity and catfishes that are representatives of both European and southern Asian species, the Shatt Al-Arab in the Mesopotamian Tigris-Euphrates basin raises doubts about the evolutionary distinctness of this group of species for the area (4). The phylogeny of catfishes in the genus Silurus is one instance of debate. A synonym for the Far Eastern species of *S. asotus* is *Silurus chantrei*. Similar to *S. Galanis*, *S. triostegus* has been proposed to represent a variation in Mesopotamia (4). These fish are generally considered a good food source for many people. Furthermore, much research has been done on this fish, and the most recent research studied the use of parts of this fish to make biodiesel (5). One of the most vital components of the ecosystem is water. Water resources support growth in socioeconomic areas vital to society, particularly for businesses, agricultural activities, and residential consumption. One of the most challenging problems people have ever faced is supplying safe drinking water for the world's expanding population in the twenty-first century (6). Both biotic and abiotic influences determine the quality of water. The other elements have been present on Earth since the planet's origin, except for the metals that man has produced via nuclear reactions and other chemical processes (7). Although there have been isolated instances of local metal pollution due to natural weathering, anthropogenic activities have made metals a concern for environmental health (8). It was proposed that the primary metals released by mining and smelting operations from the bedrock could produce pollution. It is well known that aquatic ecosystems' heavy metals (HM) are caused by both natural processes and discharges or leachates from several of anthropogenic activities (9). An environmental issue of concern to human health is the hazardous heavy metal contamination of terrestrial and aquatic ecosystems. Heavy metals are persistent contaminants that build up in the environment and poison food systems. Potentially harmful heavy metal buildup in biota poses a health risk to its consumers, including humans (10). Pb, Hg, Cd, Cr, Cu, Zn, Mn, Ni, Ag, etc., are the principal heavy metals. The heavy metals Pb, Cu, and Zn are considered the most hazardous to the environment, humans, and fish. High levels of heavy metals are hazardous because they produce bioaccumulation in organisms, toxic effects on biota, and even mortality in most living things, destabilizing ecosystems (11). All heavy metals have deleterious effects on organisms through metabolic interference and mutagenesis, even though some require micronutrients (11). The body and the food chain are potential sites for hazardous metal bioaccumulation. Consequently, hazardous metals typically show persistent toxicity (12). However, industrialization and agricultural innovations are increasingly blamed for these environmental issues (13).

Toxic heavy metals, including arsenic (As), mercury (Hg), cadmium (Cd), copper (Cu), zinc (Zn), and lead (Pb), are present in the ecosystem regularly. They are believed to be the most harmful to humans, fishes, and the environment, and their levels are rising due to of anthropogenic activities endangering aquatic species and people (11,13). Depending on the toxicity of these metals, the current study aimed to determine the levels of arsenic (As), cadmium (Cd), copper (Cu), mercury (Hg), lead (Pb), zinc (Zn), and zirconium (Zr) in five parts of the catfish. They were represented by the skin, liver, muscles, gills, and ovaries.

Materials and methods

Ethical approve

The approval was given to conduct this research by University of Basrah, College of Education/ Qurna in their book No. 7/35/38 on 10/1/2022.

Sampling

Catfishes (*Silurus triostegus*, H. 1843) samples were obtained from the Shatt Al-Arab River from the northern part of the Shatt Al-Arab in March 2022, the samples of fish were obtained from fishermen (Figure 1). The fish sample groups were separated into three parts and then the skin, liver, muscles, gills and ovaries were separated from each of the three parts to obtaining three replicates. The separated samples were dried in the oven laboratories of the Department of Biology, College of Education /Qurna, the University of Basrah at 50-60°C. After that, the samples were crushed, kept in special boxes, and sent to Beamgostar Tapan Company in Tehran-Iran for sample analysis. The samples were digested using acids and analyzed according to EPA Method 200.7 (14). The samples were analyzed to determine the concentrations of the heavy metals in the study in the studied parts by the inductively coupled plasma mass spectrometry (ICP-MS) device. On the other hand, all the statistical analyses utilized the program SPSS ver.25 for analyzing data using the ANOVA test for homogeneity data and the Brown-Forsythe test for non-Homogeneity data at $P< 0.05$ significance levels.

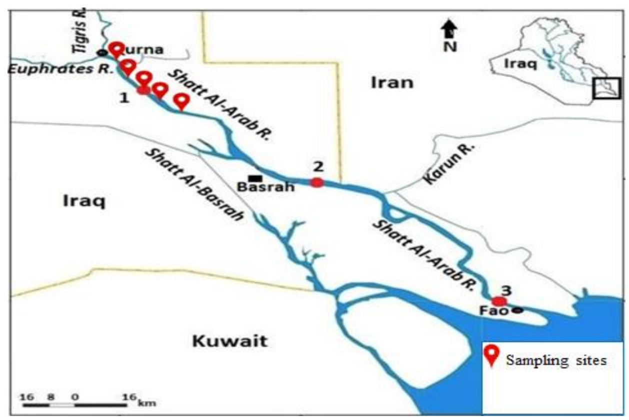

Figure 1: Sampling sites for catfishes.

Results

Statistical description

The statistical results of the current study showed that most of the data were non-Homogeneity when using a Levene test. The Brown-Forsythe test was resorted to instead of the ANOVA test in the non-Homogeneity data to know the statistical differences between the groups at 0.05 using the Duncan test. The data showed that the skin, liver, muscles, gills, and ovaries groups were non-Homogeneity. In contrast, at the level of the metal groups, it was found that zinc and zirconium were Homogeneity. In the data for which there are statistically significant differences, Duncan’s test divided the groups into those that included group (a), the most effective, followed by group (b), the least effective all the way down to the least influential groups (Tables 1-5).

The skin, liver, muscles, gills, and ovaries

According to table 1 data, the skin had the highest mean for the zinc element, followed by the copper, with an accumulation value of 45.74 and 2.27 ppm, respectively. The results showed that the value of the Brown-Forsythe test was 103.799 with a statistical significance value of 0.008> 0.05 (there are statistically significant differences), the zinc was the most influential element on the skin. Moreover, the accumulation of elements in the liver showed statistically significant differences in the accumulation of elements. The zinc element came in the first level, the most accumulated in the liver, followed by the copper element. In contrast, the lowest accumulation level came for the following elements (mercury - lead - zirconium - cadmium - arsenic) (Table 2). On the other hand, there are no statistically significant differences in the accumulation of elements in the muscles, as the zinc element recorded the highest rate of accumulation of 68.55 ppm followed by the lead element with a rate of accumulation of (7.11 ppm) (Table 3). At the same time, the accumulation of the elements in gills showed statistically significant differences. The arrangement of the accumulation of the metals in the gills was as follows (Zn>Cu>Pb>Zr>Hg>As>Cd) (Table 4), while in the ovaries, it was as follows (Zn>Cu>Pb>Zr=Hg=As=Cd) (Table 5).

Table 1: The accumulating means of metals and statistical data description in the skin

Metals	N	Mean (ppm)	SD	SE	95% Confidence Interval		Min	Max
					Lower	Upper		
As	3	0.22	0.21	.12	-0.31	0.75	0.09	0.47
Cd	3	0.09	0.01	.005	0.06	0.11	0.08	0.10
Cu	3	2.27	1.20	.69	-0.73	5.27	1.34	3.64
Hg	3	0.14	0.045	.026	0.03	0.25	0.10	0.19
Pb	3	0.34	0.23	.13	-0.23	0.92	0.09	0.55
Zn	3	45.74*	7.59	4.38	26.88	64.59	37.5	52.45
Zr	3	0.10	0.005	.003	0.09	0.12	0.10	0.11
Total	21	6.98	16.40	3.58	-0.48	14.45	0.08	52.45

* mean significant at P<0.05.

Table 2: The accumulating means of metals and statistical data description in the liver

Metals	N	Mean (ppm)	SD	SE	95% Confidence Interval		Min	Max
					Lower	Upper		
As	3	0.09	0.01	0.005	0.06	0.11	0.09	0.08
Cd	3	0.09	0.01	0.005	0.06	0.11	0.08	0.08
Cu	3	18.72*	6.00	3.46	3.81	33.63	1.34	11.81
Hg	3	0.34	0.13	0.075	0.017	0.66	0.10	0.26
Pb	3	0.18	0.13	0.076	-0.14	0.51	0.09	0.10
Zn	3	68.55*	12.89	7.44	36.51	100.58	37.5	55.51
Zr	3	0.11	0.02	0.015	0.04	0.17	0.10	0.09
Total	21	12.58	24.72	5.39	1.32	23.84	0.08	0.08

* mean significant at P<0.05.

Table 3: The accumulating means of metals and statistical data description in the muscles

Metals	N	Mean (ppm)	SD	SE	95% Confidence Interval		Min	Max
					Lower	Upper		
As	3	0.21	0.13	0.07	-0.11	0.54	0.10	0.36
Cd	3	0.09	0.01	0.005	0.06	0.11	0.08	0.10
Cu	3	1.61	0.42	0.246	0.55	2.67	1.24	2.08
Hg	3	0.66	0.22	0.13	0.10	1.21	0.40	0.80
Pb	3	7.11	12.16	7.02	-23.09	37.32	0.09	21.16
Zn	3	22.18	4.70	2.71	10.49	33.86	16.75	25.00
Zr	3	0.10	0.015	0.008	0.06	0.14	0.09	0.12
Total	21	12.58	24.72	5.39	1.32	23.84	0.08	81.30

Table 4: The accumulating means of metals and statistical data description in the gills

Metals	N	Mean (ppm)	SD	SE	95% Confidence Interval		Min	Max
					Lower	Upper		
As	3	0.12	0.03	0.02	0.03	0.22	0.10	0.17
Cd	3	0.09	0.01	0.005	0.06	0.11	0.08	0.10
Cu	3	3	3.70	2.20	-1.27	-1.77	9.18	2.42
Hg	3	0.13	0.032	0.018	0.05	0.21	0.11	0.17
Pb	3	0.23	0.13	0.07	-0.08	0.55	0.10	0.36
Zn	3	73.72*	4.81	2.78	61.75	85.69	70.54	79.27
Zr	3	0.19	0.09	0.052	-0.030	0.41	0.10	0.28
Total	21	11.17	26.25	5.72	-0.77	23.12	0.08	79.27

* mean significant at $P<0.05$.

Table 5: The accumulating means of metals and statistical data description in the ovaries

Metals	N	Mean (ppm)	SD	SE	95% Confidence Interval		Min	Max
					Lower	Upper		
As	3	0.09	0.01	0.005	0.06	0.11	0.08	0.10
Cd	3	0.09	0.01	0.005	0.06	0.11	0.08	0.10
Cu	3	3.44*	0.74	0.43	1.58	5.30	2.59	3.97
Hg	3	0.09	0.010	0.005	0.06	0.11	0.08	0.10
Pb	3	0.10	0.02	0.01	0.05	0.15	0.09	0.13
Zn	3	68.60*	2.37	1.37	62.70	74.50	65.95	70.53
Zr	3	0.09	0.01	0.005	0.06	0.11	0.08	0.10
Total	21	10.35	24.40	5.32597	0.75	21.46	0.08	70.53

* mean significant at $P<0.05$.

The accumulation of metals and the level of danger

At the level of the elements, there are no statistically significant differences in the accumulation of arsenic on the parts of the catfish body. The highest accumulation of arsenic was in the skin, followed by muscles at a rate of 0.22 and 0.21 ppm, respectively. In addition, the accumulation of cadmium in the parts of the catfish body did not appear to have any apparent differences, with a cumulative value of 0.9 ppm in all body parts studied. In comparison, the results of the copper element showed that the value of the Brown-Forsythe test is 17.996 with a p-value of 0.023> 0.05 (there are statistically significant differences in accumulation in parts of the body). In addition, it was found that there are statistical differences (p-value 0.024) in the accumulation of mercury metal in the parts of the body, as they reached the highest value of accumulation of this element in the muscles 0.66 ppm. The lowest accumulation value was recorded in the ovaries 0.09 ppm. On the other hand, the arrangement of the accumulation of lead (p-value 0.566) in the body parts was as follows (muscles> skin> gills> liver> ovaries), while the zinc (p-value 0.000) was as the following (gills> ovaries> liver> skin> muscles). Moreover, the accumulation of the zirconium element did not appear to have any statistical differences, as the highest accumulation value was recorded in gills at the rate of 0.19 ppm. The ovaries had the lowest accumulation value 0.09 ppm (Figures 2-8).

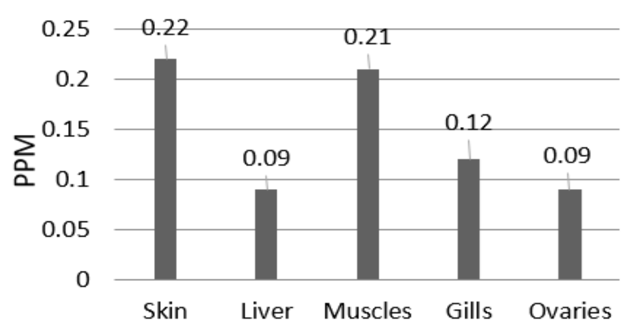

Figure 2: Arsenic concentration in different organs.

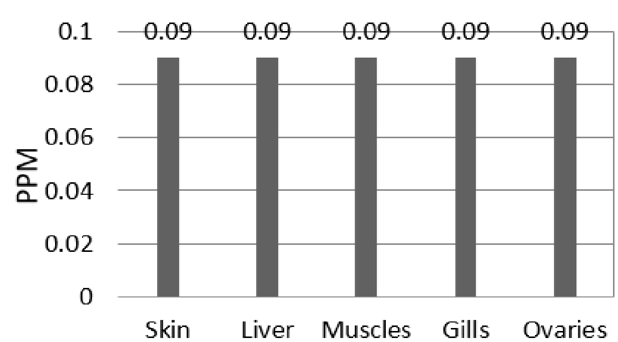

Figure 3: Cadmium concentration in different organs.

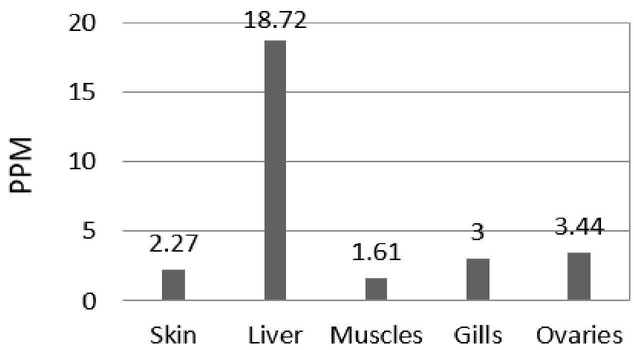

Figure 4: Copper concentration in different organs.

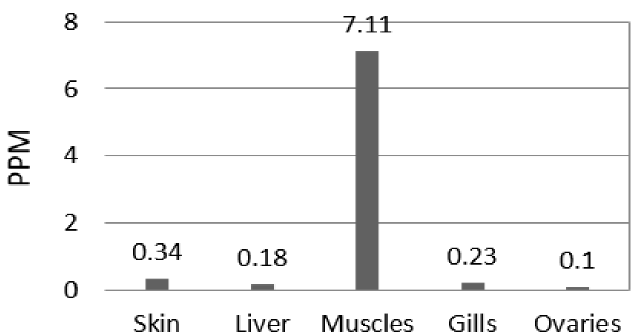

Figure 5: Lead concentration in different organs.

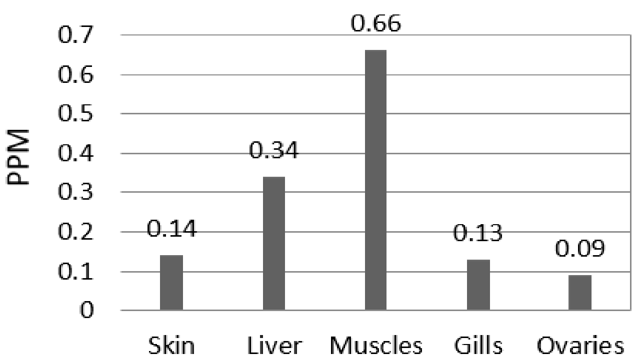

Figure 6: Mercury concentration in different organs.

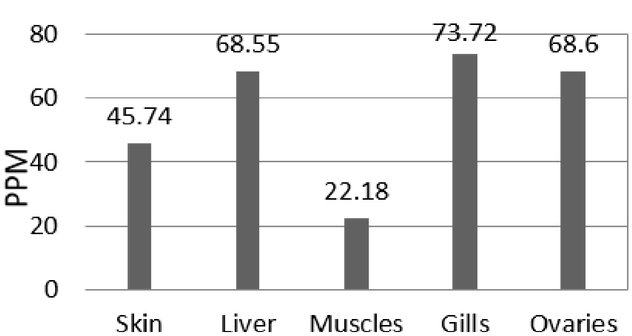

Figure 7: Zinc concentration in different organs.

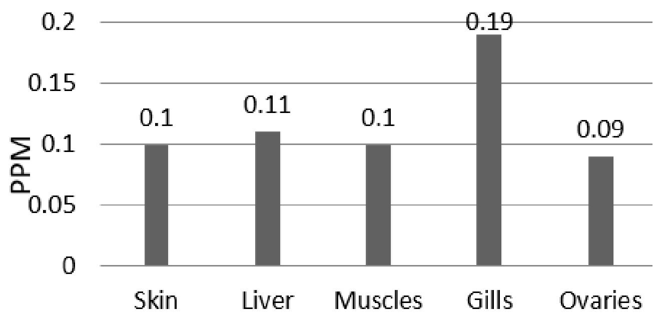

Figure 8: Zirconium concentration in different organs.

Discussion

Unsaturated omega fatty acids and fish's high protein content are known to improve human health. As a result, they are now among the most widely consumed seafood and a vital source of protein for people (11,15-18). In freshwater ecosystems, fish are often at the top trophic level and absorb heavy metals from their surroundings due to many factors, such as species features, exposure time and concentration, and water parameters (19,20). According to toxicological risk, heavy metals are among the most dangerous chemical pollutants for people and other living things (17, 21). Through the trophic level, harmful elements such as heavy metals brought on by human activity build up in aquatic life (22,23). Public health risks can result from eating fish exposed to these dangerous compounds (24,25). One of the most severe problems affecting the environment and human health is the heavy metal contamination of fish (26). It was shown that consuming some fish species might provide a toxicological risk and harm population health (21,23). Therefore, the current study provides information on the accumulation levels of arsenic, cadmium, copper, mercury, lead, zinc, and zirconium in catfish to know the level of risk of these metals.

Arsenic

In the current study, the arsenic levels in the catfish's various body sections are not statistically different at the elemental level. The skin and muscles accumulated arsenic at rates of 0.22 and 0.2167 ppm, respectively, and the skin accumulated arsenic at the most significant rate. One of the most harmful, widely dispersed toxins that endanger the health of people, animals, and fish is arsenic (As). The findings overwhelmingly demonstrate that acute exposure to As and high temperatures can cause substantial detrimental changes in stress indicators and fish cellular and metabolic activity (27). Depending on the edible part of the fish, represented by the muscles, it was found that the concentration of arsenic in the current study is 0.2167 ppm. It is not a high concentration compared to what was indicated in fishes in Iran (28), the Bangshi River, Bangladesh, the Black Sea, Turkey, the Mediterranean Sea, Italy, and Chile

Mediterranean Sea, Spain. Depending on its chemical structure, arsenic's toxicity can take various forms and is quite complicated as oxidative stress processes are mostly linked to toxicity (29).

Cadmium

Cadmium is becoming more abundant in freshwater systems due to anthropogenic activities, which worries fisheries and aquaculture because it is poisonous in trace amounts and has no recognized biological purpose (30). However, there is still an unknown about how freshwater fish respond to repeated exposure to ecologically relevant amounts (30). When polluted with substances such as cadmium (Cd), fish can also be dangerous, especially if they are taken in high amounts (31). When ingested in large quantities, this element can accumulate in tissues and seriously impact human health. Long-term exposure to them may cause cancer, cardiovascular illness, or peripheral neuropathy. According to the EFSA Panel on Contaminants in the Food Chain (CONTAM) (32). Exposure to Cd at work or in the environment can result in persistent health problems. The most prevalent ones affect the lungs, heart, blood vessels, liver, kidneys, musculoskeletal, and reproductive systems. Also regarded as a carcinogen is cd. It can exacerbate cancer in many organs, including the lungs (33).

Furthermore, in the present study, there were no noticeable changes in the body's accumulation of cadmium, which had a cumulative value of 0.9 ppm in all parts of the examined catfish. Compared to the low cadmium concentration in the current study, one of the metallic elements that cause the most worry in the human diet and the environment is cadmium. This may be because the area does not contain high concentrations of it and the mechanisms of treatment by the fish. Most foods contain cadmium in the 0.005-0.1 mg/kg range. For example, foods such as mushrooms and oysters may have substantially more significant quantities. On the other hand, fruits and drinks have the least cadmium of all food sources. The primary sources of cadmium ingestion are vegetables, cereals, and cereal products (34).

Copper

Low concentrations of copper are frequently found in aquatic ecosystems in their natural settings. Aquatic habitats are vulnerable to copper pollution near ultimate receptors of industrial and urban waste and atmospheric deposition from copper mining and smelting ores, which increases copper concentrations in aquatic ecosystems (35). For this reason, it is crucial to analyze copper toxicity in aquatic organisms. Copper levels higher than those necessary for a species to grow and develop can accumulate and have disastrous effects (36). These levels are a major problem worldwide. The copper element's results show that there are statistically significant variations in accumulation in body parts. The Brown-Forsythe test value is 17.996, with a value of 0.023>0.05. In the current investigation, the fish liver showed the maximum copper accumulation at a rate of 18.72 ppm, whereas the muscle showed the lowest frequency at a rate of 1.61 ppm. These percentages do not pose a risk to people compared to their lethal levels. Most foods naturally contain copper as copper ions or salts (37). Generally, the content of copper in meals is around 2 mg/kg or less, the primary sources being meat, offal, fish, nuts, milk chocolate, and green vegetables (38). However, values of up to 39 mg/kg for cocoa and liver have been documented.

Mercury

The primary pollutant in aquatic ecology is mercury (Hg). Therefore, to track contamination, it is necessary to identify particular indicators of mercury toxicity in fish (39). Fish, meat, and vegetables contaminated with mercury result from polluted water. Microbiologically, inorganic mercury is converted to the lipophilic organic molecule "methylmercury" in aquatic settings. Mercury is more susceptible to bio magnification in food chains due to this transition. Therefore, populations that have historically consumed food from fresh or marine environments have the highest dietary exposure to mercury. People who regularly consume fish or a certain kind of fish are at an elevated risk of methylmercury poisoning, according to an extensive study on natives throughout the world (40). In the present study, it was discovered that there are statistical disparities in the accumulation of mercury metal in the various bodily regions, with the muscles having the most significant level 0.66 ppm and the ovaries having the lowest accumulation level 0.09 ppm. On the other hand, exposure is increased by the toxin's simple accessibility to humans through several channels, including air, water, food, cosmetics, and even immunizations. Children and fetuses are particularly vulnerable to mercury contamination. Mercury poisoning is transmitted to fetuses and newborns through breast milk by mothers who consume mercury-containing foods. Children exposed to supposedly acceptable mercury levels have reportedly performed worse in memory and motor function. Adults exposed to low mercury levels also experienced disturbances in their verbal memory, concentration, and fine motor skills. (40)

Lead

In the current research, the muscles > skin > gills > liver > ovaries were the order in which led to accumulation in the body components of catfishes with 7.11 ppm for muscles. Lead poisoning is a significant environmental illness with catastrophic consequences for the human body. The harmful effects of lead on human bodily functions are essentially universal (41). Lead's negative consequences are many, and there is no recognized physiologically relevant purpose for lead in the body (42-44). Aquatic species are impacted by lead that enters water bodies from the atmosphere and soil.

Due to this circumstance, several studies have been conducted to determine how this metal affects the biological processes of aquatic species, notably fish immune systems. Thus, it may be inferred that lead impacts a fish's immune system, leaving it vulnerable to infections and immunosuppressed (45).

Zinc

The natural environment is rich in zinc, a crucial trace element for aquatic life and people (46). When zinc intake is too high, it may negatively affect organisms (47). The US EPA published water quality criteria for zinc in 2009; the criteria for human health are 7400 g/L (ingested potable water + edible aquatic organisms grown in the water) and 26,000 g/L. The criteria for zinc to protect freshwater aquatic organisms are 120 g/L (short-term hazardous concentration) and 120 g/L (long-term hazardous concentration) (edible aquatic organisms only). Aquatic life is significantly more sensitive than people are to zinc concentrations in water. China is the second-largest country in the world regarding zinc deposits, extraction, import, and consumption, according to data from the National Bureau of Statistics (48) .In this study, zinc was recorded in high concentrations compared to the other studied elements, as the order of zinc accumulation was as follows (Gills > Ovaries > Liver > Skin > Muscle). Despite the high zinc concentrations in some catfish sections, most meals and beverages contain zinc, making them the principal sources of zinc in the diet (49). Meats, particularly organ meats, whole grain cereals, and dairy products, including cheese, are significant sources of zinc consumption (37). Up to 100 mg/kg of oysters and 30 mg/kg of peanuts may be present.

Zirconium

It is unclear how zirconium (Zr) affects biological systems. It is more prevalent than most trace elements in nature, making it omnipresent. Plants absorb it from the soil and water, accumulating it in specific tissues. The manner of exposure and the concentration in the immediate surroundings impact the entrance into animal systems in vivo. Retention begins in the soft tissues before gradually moving on to the bone. The metal can pass through the placental and blood-brain barriers to enter milk after being implanted in the brain. Human absorption has been estimated to be as high as 125 mg per day. Histological and cytological tests have revealed a reasonably low level of toxicity. Very high concentrations of a substance can have non-specific harmful effects. Zr has not yet been connected to any specific metabolic activity, despite its availability and retention in relatively significant concentrations in biological systems. Very little information about its interaction with the chemical components of genetic systems, including nucleic acids. Metal does not appear to be an essential or harmful element in the traditional sense. However, since this element is used in more and more innovative products and as a result of radioactive fallout, there is a greater need to understand how it affects living things (50). According to the current study, there was no substantial risk of zirconium element buildup, with the highest accumulation rate found in the gills 0.19 ppm and the lowest in the ovaries 0.09 ppm. These rates are taken into account to be safe for humans. The poor condition of fish is eventually a threat to human health due to the high concentration of metal toxicants in aquatic environments such as zirconium. These dangers primarily exist in mineral-rich regions. human activities such as mining cause an increase in metal concentrations in aquatic bodies (51). Based on the fishing area comparison, it seems that the environment in the north of the Shatt Al-Arab is safer than the south of Basra in terms of the accumulation of different elements, which agrees with (52).

Conclusion

In the current study, the studied items did not accumulate at high rates in the catfish. This may be due to the environment of the study area and the mechanisms of treating these types of metals by the catfish. The highest rate of arsenic accumulated was 0.22 ppm in the skin, while no variations in the accumulation of cadmium appeared in the parts of the body 0.9 ppm in all parts. In addition, according to the eating part, the statistical results revealed that mercury accumulation in muscles was 0.66 and 7.11 ppm for lead, while the higher accumulation of zinc and zirconium was in the gills with 73.72 and 0.19 ppm respectively.

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Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication or funding of this manuscript.

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دراسة بعض المعادن السامة في أجزاء من سمك الجري في نهر شط العرب

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الخلاصة

وفقًا لسميتها، يُعتقد أن المعادن الثقيلة السامة مثل الزرنيخ والزئبق والكادميوم والنحاس والزنك والرصاص هي الأكثر ضررًا للإنسان والأسماك والبيئة. ونظرًا لارتفاع مستوياتها بسبب الأنشطة البشرية. سعت الدراسة الحالية إلى التأكد من مستوى المعادن الثقيلة السامة في خمسة أجزاء من سمك الجري (الجلد والكبد والعضلات والخياشيم والمبايض)، تم جمع العينات من الجزء الشمالي لشط العرب في آذار ٢٠٢٢. تم استخدام جهاز مطياف الكتلة البلازمية المقرونة بالحث وذلك للكشف عن مستويات المعادن المستهدفة. أظهرت النتائج أن الزرنيخ يتراكم في الجلد والعضلات بمعدل (٠,٢٢ و ٠,٢١ جزء في المليون) على التوالي بينما لا تختلف مستويات الزرنيخ في أجزاء الجسم المختلفة إحصائيًا. بالإضافة إلى ذلك، لم يظهر الكادميوم أي اختلافات ملحوظة في جميع أجزاء الجسم المدروسة. علاوة على ذلك كان للكبد أكبر تراكم للنحاس بمعدل (١٨,٧٢ جزء في المليون). من جهة أخرى تبين أن تراكم الزئبق في أجزاء مختلفة من الجسم يختلف إحصائيًا، مع وجود أعلى المستويات في العضلات (٠,٦٦ جزء في المليون). بالإضافة إلى ذلك كان عنصر الزنك يتراكم في أجزاء الجسم بالتسلسل التالي: الخياشيم، المبايض، الكبد، الجلد، والعضلات على التوالي، بينما كان التراكم بالتسلسل التالي: العضلات، الجلد، الخياشيم، الكبد، والمبايض على التوالي لعنصر الرصاص. من جانب أخر لا توجد فروق ذات دلالة إحصائية في كمية الزركونيوم المتراكم. وفقًا للدراسة الحالية، فإن أجزاء جسم سمك الجري المستهدفة لم تراكم معادن ثقيلة سامة بمعدلات عالية وقد يكون هذا بسبب بيئة منطقة الدراسة إضافة الى آليات معالجة هذه الأنواع من المعادن بواسطة سمك الجري.