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Evaluation of Some Heavy Matels in Frozen Mugil Fish of Dhi-Qar Governate

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ABSTRACT
In this study, the concentration level of some heavy elements, including copper, cadmium and zinc, was determined in the gills, digestive tract and muscles of *Mugil* fish. *Mugil* fish were chosen for their availability and abundance at the study stations (Nasiriyah City and Al-Jabaish). The concentrations of heavy metals in fish and their nutritional content were measured. Differences in the concentration of heavy metals were observed between the studied parts. The highest concentrations were recorded in the digestive tract, while the lowest concentration of heavy metals was recorded in the muscles. Compared to the limits set by the World Health Organization, some values exceeded the permissible limits. Fish are important and the presence of metals in their bodies leads to metals' transmission through the food chain to humans, causing numerous diseases and serious problems resulting from the increase of heavy metals in fish and the environment. Thus, the aim of the study was to investigate the effect of heavy metal accumulation in frozen and fresh fish on human consumers.

INTRODUCTION

Various human acitivities affect the aquatic environments, change the quality of natural water, and greatly affect living organisms. River ecosystems near urban and rural lands are exposed to various forms of pollution, such as industrial, agricultural and health pollutants **(Chen *et al.*, 2022)**. Pollution has led to the deterioration of aquatic life diversity, as factories and other human activities dump their waste into all water bodies. There are many sources of pollution that make the aquatic biotic in danger like hydrocarbons and heavy metals, espcially in Iraqi river **(Abedali *et al.*, 2021)**. Heavy metals have the ability to accumulate in many kinds of aquatic biota (fsh, plant and Gastropoda, etc.) which can be used as biodcator for pollution **(Jawed *et al.*, 2022)**. These heavy metals accumulate in various organs of fish such as muscles, gills, which reduces their vital activities and may lead to their death **(Shah, 2017)**. Sources of heavy metal pollution include various mining wastes, sewage, runoff from residential areas, and natural phenomena such as volcanoes, floods, and rock erosion. Heavy metals are toxic, possibly carcinogenic, and can bioaccumulate in living organisms. Heavy metals can cause significant damage to various organs in the body when their quantities exceed the limits specified by international organizations, including the nervous system, liver, lungs, and others, and some have been found to cause damage, even at low exposure levels **(Aziz *et al*., 2023)**. Heavy metals such as lead, cadmium, chromium, copper, mercury and arsenic exhibit high toxicity. They have consequences for aquatic life, disrupting microbial ecosystems and causing significant physiological stresses in plants, including yellowing, stunted growth and a marked reduction in biomass production **(Davidson *et al.*, 1998)**. The Euphrates and Tigris rivers are vital water resources in Iraq. It was found that their sources of pollution are numerous, but the most important are heavy metals. Some heavy metals are essential for life, but they can become toxic through their bioaccumulation and bio magnification in the food chain of living organisms, as they cannot be easily disposed of in ecosystems through natural processes, compared to most other organic pollutants. These elements are dangerous pollutants that enter the freshwater environment and cause an imbalance in the ecosystem, which is directly or indirectly reflected in humans **(Al-Sarraj *et al.*, 2022)**. Fish is one of the most important indicators reflecting the presence of heavy metals; in addition, fish are vital indicators that collect and accumulate pollutants available in the surrounding habitat, and this in turn shows the trends of bioconcentrations in the bodies of organisms **(Förstner & Wittmann, 2012)**. Fish is one of the most important foodstuffs available in particular and in general in the markets; within the food chain, fish occupies the top of food chains and webs because it has a relatively long life in addition to being able to collect pollutants in their bodies and thus used as vital and biological indicator **(Golestaninasab *et al.*, 2014)**. Fish contains many proteins in addition to polyunsaturated and unsaturated fatty acids, especially omega-3 fatty acids, calcium, zinc, iron and other minerals **(Chan *et al.*, 1999)**. It has a role in reducing cholesterol in the bloodstream in addition to reducing and reducing injuries in heart disease and strokes **(Rashed, 2001; Storelli, 2008; Al-Busaidi, 2011)**. Fish are highly exposed to pollution compared to other aquatic animals, especially heavy metals, as fish are one of the most important bio-indicators of chemical pollution and have long been used as a guide to identify metal pollution in aquatic environments. Fish are the best indicators for identifying indicators in cases of pollution when taking water samples due to the accumulation of pollutants inside the fish body parts **(Maurya *et al*., 2019; Malik *et al*., 2020)**. The increasing demand for the safety of food and other food materials has expanded the scope of research on the impact and risks of heavy metals on organisms within the food chain **(Elmoselhy *et al*., 2014)**. The aim of this study was to determine the accumulation of heavy elements in different parts of fresh and frozen fish during different seasons.

MATERIALS AND METHODS

Numerous *Mugil* fish samples were collected for this study from different local markets in the districts of Thi-Qar Governorate (Nasiriyah and Al-Jabayesh) during the winter and summer seasons of 2024. Different parts of the body such as muscles, gills and digestive tract were selected for the purpose of analysis and detection of heavy metals that accumulate in different parts of the fish body. For each fish sample, different tissues were separated using a stainless knife, followed by labeling for storage in polyethylene bags and then kept in the refrigerator on the same day of collection, until they were sent to the Shatra Institute of the Southern Technical University to conduct the necessary tests to detect heavy metals in those tissues after digestion according to the method described in **Nwajel (2000)**. The digested solution was stored in special plastic bottles until the necessary tests were conducted to detect heavy metals. The digestion processes of the sample were repeated for each part of a sample and another sample as well three times. To prevent contamination, all the tools used were cleaned and washed well with nitric acid before the digestion process. Heavy metals were detected using an Atomic Absorption Spectrometer instrument (Pg AA500 English).

The results and variables of the current study were evaluated statistically using the Statistical Package for Social Sciences program (SPSS) program version 26 (2019), two way ANOVA at a probability of $P \leq 0.05$ as a significant level.

RESULTS AND DISCUSSION

Table (1) exhibits the concentration of cadmium in fresh and frozen Bayah fish. *Mugil* species from Nasiriyah recorded the highest mean concentration value of 14.30±0.26μg/ g dry weight in gut during winter season in frozen fishes while the lowest mean concentration was 0.07±0.22μg/ g dry weight during summer in fresh fishes. For Al-Jabayesh, the highest mean concentration value was 14.53 ±0.35μg/ g dry weight during winter. The lowest mean concentration was 3.13±0.13μg/ g dry weight during winter in frozen fish. The results of the statistical analysis showed that there are significant differences at the level of $P \leq 0.05$ between the free and frozen fish in studied fish. Interestingly, some heavy metals concentrate in diverse part of fish therefore they could be used as bioindicators for contamination **(Farhood, 2015)**. It was expected that the second station (Al-Jabayesh) would have the highest cadmium concentration since this area was an agriculture area, hence it had a heavily populated waste, adding to that the resident people use pesticides causing the river to receive more pollutants and agricultural effluents. The mean concentrations of heavy metals in the gut, gills, and muscles of Bayah fish in both locations (Station 1: Nasiriyah and Station 2: Al-Jabayesh) were higher than the World Health Organization (WHO) maximum permissible levels of heavy metals in freshwater fishes **(Suski,, 2006)**. HMs -accumulate in fish through absorption from the water, skin and ingestion of contaminated food during processing or storage **(Mziray & Kimirei, 2016)**. This result is less than that recorded in the study of **Ahmed *et al*. (2010)** and greater than those recorded for fish from Daya Bay, China (0.002–0.083μg/ g) **(Gu *et al*., 2016)**.

Table (2) shows the concentration of copper in fresh and frozen Bayah fish. In Nasiriyah, the highest mean concentration value was 12.46±0.45µg / g dry weight in gut during winter season in frozen fish in Nassriyah City, while the lowest mean concentration was 0.56±0.02 µg / g dry weight in muscles during summer in fresh fish. In Al-Jabayesh, the highest mean concentration value was 14.30±0.26µg/ g dry weight during winter. Whereas, the lowest mean concentration was 2.07±0.22µg / g dry weight during winter in frozen fish. It is worthnoting that Cu is a main pollutant of aquatic systems. Cu toxicity affects reproductive organs, fecundity, hatching rate and fertilization **(Santos, 2018)**. Copper element plays an essential role in fish metabolism and in many enzyme reactions **(Sivaperumal *et al*., 2007)**. Interestingly, the high concentration of Cu could destroy the kidney **(Satheeshkumar *et al*., 2011)**. The present result are lower than the findings of **Ahmad *et al*. (2015)** in the River Kabul, Pakistan. However, the present values are higher than those reported by **Türkmen *et al*. (2005)** in the central Aegean and Mediterranean seas (0.34–7.05mg/ kg). Whereas, the present result is within the value of the WHO (ppb1000).

Table (3) exhibits the concentration of zinc in fresh and frozen Bayah fish. In Nassriyah, the highest mean concentration value was 144.67±3.78µg/ g dry weight in gills during summer season in frozen fish in Nassriyah City, while the lowest mean concentration was 60.67±7.02µg/ g dry weight muscle during winter in fresh fish. For Al-Jabayesh, the highest mean concentration value was 146.33±3.05µg/ g dry weight during summer in frozen fish. The lowest mean concentration was 54.00±4.58µg/ g dry weight during summer in frozen fish in gills. Zn is an important element that regulate the normal growth, development, and delays sexual maturation. In the present study, zinc element has the highest concentration but is still below the permissible limits. In this context, the study agrees with the findings of **Makedonski *et al*. (2015)**. Zn tends to concentrate in the gills, making it the first part that gets affected upon receiving the element. The accumulation of zinc in gills result in the damage of respiration tissue leading to death **(Afshan *et al*., 2014)**. Al-Jabayesh was recorded with the highest concentration of zinc compared to Nassriyah. This occurred due to the weathering of geological rocks and human activities in the area, including the release of domestic wastewater. Zn toxicity negatively affects fish by harming reproduction, growth, and feed intake, as well as reducing body protein and lipid levels and interfering with bone formation **(Abdel-Tawwab, 2016; Gupta, 2021)**. The present results fall within the WHO recommended limit (200 ppb). Furthermore, muscle tissue showed the lowest mean concentration of heavy metals, likely because it is less active in metal accumulation **(Talib *et al*., 2022)**.

Tale 1. Mean concentrations of cadmium (ug/kg) in the fresh and frozen *Mugil* fish

Sample	Part used	Sample	Part used		
			Gills	Digestive tract	Muscle
Nasiriyah	Winter	Frozen	9.86±0.15 B ab	14.30± 0.26 A a	3.98±0.02 C a
		Fresh	8.46± 0.45 Bab	9.73 ±0.20 A e	2.91±0.49 C ab
	Summer	Frozen	9.45±0.03 B a	11.69±0.14 A c	2.64±0.03 C ab
		Fresh	8.63±0.25 B c	12.66±0.20 A c	2.07±0.22 C b
Al-Jabayesh	Winter	Frozen	9.93 ±0.25 B a	14.53 ±0.35 A a	3.13±0.13 C a
		Fresh	5.33±0.60 B d	7.33±0.25 A f	2.47±0.07 C ab
	Summer	Frozen	10.17±0.16 B a	11.33±0.57 A d	3.03±0.12 C a
		Fresh	8.26±0.25 B b	13.00 ±0.25 A b	2.08±0.28 C b

a-f Different alphabets within the same column mean significant differences below the probability level of 0.05.
A-C Different alphabets within the same row mean significant differences below the probability level of 0.05.

Table 2. Mean concentrations of copper (ug/kg) in the fresh and frozen *Mugil* fish

Sample	Part used	Sample	Part used		
			Gills	Digestive tract	Muscle
Nasiriyah	Winter	Frozen	5.30 ± 0.30 Bde	9.56 ± 0.30 Ae	1.16 ± 0.29 Ca
		Fresh	5.10 ± 0.75 Be	12.46 ± 0.45 Aa	0.57 ± 0.10 Cc
	Summer	Frozen	6.73 ± 0.02 Ba	9.94 ± 0.44 Ad	0.93 ± 0.04 Cb
		Fresh	5.26 ± 0.02 Bde	11.25 ± 0.03 Ab	0.56 ± 0.02 Cc
Al-Jabayesh	Winter	Frozen	5.86 ± 0.15 Bc	8.90 ± 0.26 Af	1.06 ± 0.17 Ca
		Fresh	5.80 ± 0.85 Bc	10.96 ± 0.92 Abc	0.68 ± 0.02 Cc
	Summer	Frozen	6.59 ± 0.12 Bb	10.07 ± 0.15 Ac	1.21 ± 0.69 Ca
		Fresh	5.43 ± 0.04 Bd	11.25 ± 0.01 Ab	0.57 ± 0.07 Cc

a-f Different alphabets within the same column mean significant differences below the probability level of 0.05.
A-C Different alphabets within the same row mean significant differences below the probability level of 0.05.

Table 3. Mean concentrations of zinc (*ug*/kg) in fresh and frozen *Mugil* fish

Sample	Part used	Sample	Part used		
			Gills	Digestive tract	Muscle
Nasiriyah	Winter	Frozen	122.00±3.00 A e	99.33 ±8.32 B d	97.33±3.78 B b
		Fresh	142.00±6.24 A b	110.67±3.78 Bb	60.67±7.02 C a
	Summer	Frozen	144.67±3.78Ab	105.33±3.51 B c	66.67±3.21 C f
		Fresh	136.00±4.35 A c	112.33±2.51 Bb	85.00±6.24 C c
Al-Jabayesh	Winter	Frozen	127.33±3.05A d	95.66±5.13 C e	99.00±3.00 C a
		Fresh	117.00±3.60 A f	103.00±2.64 B c	70.33±6.50 C e
	Summer	Frozen	54.00±4.58 C g	103.33±4.93 B c	54.00±4.58 C g
		Fresh	76.33±2.51 C d	115.67±0.93 B a	76.33±2.51 C d

a-f Different alphabets within the same column mean significant differences below the probability level of 0.05.

A-C Different alphabets within the same row mean significant differences below the probability level of 0.05.

CONCLUSION

The concentrations of Cd, Zn and Cu were measured in this study. The mean concentration was high in the studied elements due to the overloading of agriculture and industrial waste usage of various types of fertilizers as well as the Zn and Cu concentrations. On the other hand, most metal levels were well below the recommended standards set by various authorities such as FAO, FAO/WHO, and FDA. However, cadmium (Cd) concentrations exceeded the permissible limits. It can be concluded that the frozen fish have higher heavy metals more than fresh fish.

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