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Assessment of Heavy Metal Levels in Fresh and Frozen Fish Samples from Local Markets in Basrah Province, Iraq

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Abstract

This study aimed to assess the levels of heavy metals in economically important fish species obtained from local markets in Basrah City, Iraq, during the 2021-2022 period. The fish samples, comprising *Otolithes ruber* and *Acanthoparus arabicus*, were stored in refrigerated containers until reaching the laboratory, where laboratory analyses were conducted. Flame Atomic Absorption spectroscopy was employed to estimate the concentrations of Pb, Cu, Cd, and Zn in the fish muscle tissues. In fresh fish samples, *O. ruber* exhibited Pb, Cu, Cd, and Zn concentrations of (5.774, 0.013, and 0.127) mg/kg dry weight, respectively, while *A. arabicus* showed concentrations of (5.774, 0.367, and 0.120) mg/kg dry weight, respectively. For frozen fish, *O. ruber* displayed concentrations of (3.464, N.D, 0.341, and 0.176) mg/kg dry weight, respectively, whereas *A. arabicus* demonstrated concentrations of (4.619, N.D, 0.341, and 0.135) mg/kg dry weight, respectively. These findings provide valuable information regarding the levels of heavy metals in fresh and frozen fish species from local markets in the Basrah Province, emphasizing the need for ongoing monitoring and management strategies to ensure the safety and quality of seafood products consumed by the local population.

Keywords: Heavy metals, Fish samples, Local markets, Basrah Province, Risk assessment

Introduction

Aquatic environments are contaminated by many pollutants that reach them from different sources and are harmful to human health, ecosystems, and organisms In recent decades, the world's attention to heavy metals has tended to be of life importance, with some associated with growth, development, and reproduction, most notably manganese, cobalt, copper, iron, and ceramic metals, which are toxic, exceeding the limit of their concentrations (Varol and Sen, 2012). Others are poisonous, even if they are found in low concentrations, such as Cd, Cr, Pb, Hg, and Ni. Minerals are elements that an organism's body needs directly because of their importance in body construction. Their participation in many metabolic processes in the body, fluid balance, and protein and hormone structures is key to human health. Increasing the concentration of heavy metals in the aquatic environment is also reflected by increasing their concentration in food chains; therefore, pollution is one of the most significant pressures on the aquatic environment (Al-Najare *et al*., 2014). Fish's importance and high nutritional value make them one of the most sensitive and corrupt foods because of their self-degradation with enzymes and microbial activity (Sikorski *et al.*, 1990). Heavy metals are characterized by slow degradation of organic substances and rapid degradation and transition during the food chain (Xiaolu *et al.,* 2018).

Fish cannot escape the harmful effects of contaminants (Squadrone *et al.*, 2013). Fish has been used as a guide to pollution of heavy metals in aquatic ecosystems because they are an economic resource in most countries of the world in addition to their important nutritional value (Nasr *et al*., 2012), it has been observed in some studies that fish have the potential to sensitize harmful and emergency water changes when heavy metals reach high concentration (Adeel *et al*., 2019). Fish conservation methods have varied over the ages from drying, which depends on fluid and moisture to salt, and exposure to air for several days after removing the internal innards of fresh fish (Oostindjer *et al*., 2014). It also preserves the freezer to reduce bacterial activity, keep it valid for consumption, and protect it from corruption (Zhang *et al*., 2021).

The research aims to identify the concentrations of heavy metals in the selected species, which are more harmful to human health, and to identify which species are edible without the other.

Materials and Methods:

Sampling and chemical analysis

In the present study used two species of fresh and frozen fish, *Otolithes ruber* (Bloch & Schneider, 1801) and *Acanthopagrus arabicus* (Iwatsuki, 2013),which were collecting from local markets in Basrah Governorate. Samples two were placed in refrigerated containers until they reached to the laboratory. Fish were classified in the Marine Vertebrate department. Marine Science Center laboratories according to Kuronuma and Abe (1986). Bishop (2003) and Coad (2010).

The fish were thoroughly washed with tap water, and the heads, skin, crusts, and bones were removed. Muscle samples were transferred to a freeze-dryer for drying, after which they were ground and stored until analysis.

Extraction of heavy metals from fish muscle

Then, 6 ml concentrated nitric acid and perichloric mixture was added (1:1) to 0.5 g of the sample in a Pyrex tube. The mixture was placed in a water bath at 70 ºC for 30 min, and then heat was increased from 100 to 400°C. The volume was made up to 25 ml. The concentrations of heavy metals were determined according to the method approved by ROPME (1982) using Flame Atomic Absorption Spectroscopy.

Results and Discussion

Heavy metals in fresh fish

Water is contaminated by many pollutants that affect organisms in the aquatic environment, most notably fish, which are affected by these pollutants from various sources and are important heavy metals that come from various industrial and agricultural activities that aim mostly in the aquatic environment and cause contamination (Authman *et al*., 2015). Fish muscles tend to accumulate fewer elements than other fish organs, where the mucous layer acts as the first line of defense against the passage of heavy metals into muscle tissue through the formation of complexities with the elements

(Uysal *et al.*, 2008; Nor Hasyimah *et al*., 2011).

The results of this study showed a clear variation in the concentrations of heavy metals in fresh fish muscle (Table 1 and Figure 1). The average Cu concentration in *O. ruber* and *A. arabicus* was 5.774 mg/kg dry weight, and these concentrations were below the FAO's allowable limit (FAO, 1983), with bottom fish feeding on organic crumbs at the bottom with heavy metals such as Cu, Cd, Cr, Zn, Pb and Hg (UNEP, 2006). Cu has a distinct potential for bioaccumulation in fish tissues across the food chain.

The results of the current study showed an insensitive concentration of Pb in *O. ruber* and *A. arabicus* muscles. These results were consistent with those obtained by Prasath and Khan (2008) when studying certain heavy metals in *Mugil cephalus* fish, because the device detector did not record perceived concentrations of lead.

Cd in *O. ruber* and *A. arabicus* registered concentrations of 0.013 and 0.367 mg/kg dry weight, respectively, but did not exceed the World Health Organization's (WHO, 2020) allowable limit of 0.5 mg/kg dry weight. Cadmium concentrations in our current study were higher than Al-Najare *et al.* (2012 & 2015) when studying of *A. arabicus* that catches in Razazh lake, they also disagreed with what Sarraj *et al.* (2014) found when studying the bioaccumulation of the cadmium metal in *C. carpio* and *L. Abu*, except it converged with Al-Majed *et al*. (1998), which ranged from 0.1 to 0.28 mg/kg dry weight. An increase in pH may be an important cause of varying concentrations of heavy metals in fish in aquatic environments (Srivastava and Sharma, 1996).

The results of the current study showed that the lowest concentration of zinc was recorded in *A. arabicus* at 0.120 mg/kg dry weight, whereas in *O. ruber*, the concentration was 0.127 mg/kg dry weight. These concentrations were within the Food and Agriculture Organization of the United Nations (FAO, 1983) of 30 mg/kg dry weight (Khalid *et al.*, 2017). Zinc concentrations in the current study did not agree with Al-Kahtani's (2009) study of heavy metals in Tilapia and *A. arabicus* muscles (10.72 and 25.80) mg/kg dry weight, respectively). Shaffi *et al.* (2001) found that zinc neutralizes the toxic effect of cadmium, prevents tissue intoxication, and affects the susceptibility of cadmium. Zinc is a competitive ion and one of the most important elements for natural human growth and development (Tuzen and Soylak, 2007).

Table (1). Concentration of heavy metals (mg/kg dry weight) in fresh fish muscle.

Fish Species	**Heavy Metals**			
	Copper	**Lead**	**Cadmium**	**Zinc**
O. ruber	5.774	N.D	0.013	0.127
A. arabicus	5.774	N.D	0.367	0.120

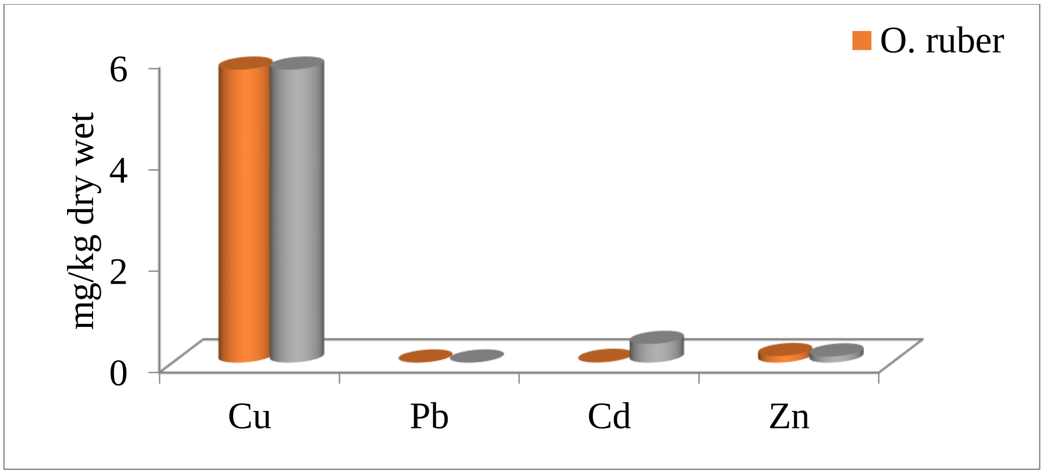

Figure (1). Heavy metal concentration (mg/kg dry weight) in fresh fish muscle.

Heavy metals in frozen fish

As shown in Table (2) and Figure (2) obtained that the concentrations of heavy metals (copper, lead, cadmium, and zinc) in frozen fish muscles, namely *O. ruber* and *A. arabicus*, showed significant variation in their concentrations.

The copper concentration was 3.464 mg/kg dry weight in *O. ruber* and 4.619 mg/kg dry weight in *A. arabicus* and did not exceed the World Health Organization (WHO, 2020) and Food and Agriculture Organization (FAO, 1983) permitted limits of 30 mg/kg. These findings coincided with the Canli and Atli study (2003), when studying six species of fish, they found that the copper concentration had ranged between (2.19 - 4.41) mg/kg dry weight, but did not show compatibility with Al-Abdulnebi (2013) when studying some frozen fish in which the concentration of copper element ranged between (13.21 - 53.74) mg/kg dry weight, and didn't agree with Alinnor and Obiji's (2010) when they study the bioaccumulation of *Sphyraena Sphyraena*, their copper concentration reached 8 mg/kg dry weight.

The atomic absorption spectroscopy did not record any sensitivity to the lead element, so the results of the lead element in the present study did not correspond to most previous studies or local studies such as Al-Abdulnebi (2013) for some frozen fish with lead element 0.35 mg/kg dry weight lead element in carp muscle, or global studies such as El-Nemr (2003) for frozen fish in Egypt like (mackerel, striped red mullet, Atlantic mackerel) and the Ganbi (2010) study of frozen hummers *Epinephelus areolatus*.

The present study recorded a Cd concentration of 0.341 mg/kg dry weight in both *O. ruber* and *A. arabicus*, which agrees with Ukoha *et al.* (2014), who studied imported fish in Nigeria and found that Cd concentrations ranged between 0.001 and 0.150 mg/kg dry weight. The FAO's allowable limit was 2.0 mg/kg dry weight (FAO, 1983). Cd and the rest of the metals are toxic contaminants of fish and have the potential to move from one nutritional level to another (Mason *et al*., 2000). Yalsuyi *et al.* (2017) obtained a decrease in cadmium levels and found that golden fish caused a rise in water hardship.

Zinc concentrations in the studied fish showed lower variation than the FAO allowance (FAO, 1983), reaching 0.127and 0.135 mg/kg dry weight in *O. ruber* and *A. arabicus*, respectively. These results are consistent with those of Alinnor and Obiji (2010). For some heavy metals in fresh and frozen fish, zinc in frozen fish recorded a concentration of 1.02 mg/kg dry weight, while the results were not agreed with both Ajani and Ayoola (2007) in the muscles of the fish *Trachurus trachurus* and *Esmacseudotolithus elongatus* in which the zinc concentrations were 44.46 and 42.26 mg/kg dry weight,respectiv. Xu and Wang (2002) referred to the bioaccumulation of zinc because of the fish's nutritional on zooplankton, which in turn is food for predators. In addition, the freezing process affects cells, temperature, storage, fish stress, and throwing related to cellular metabolism and is expected to lead to high values of certain minerals in frozen samples (Nor Hasyimah *et al.*, 2011).

Table (2). Concentrations of heavy metal (mg/kg dry weight) in frozen fish muscles.

Fish Species	Heavy Metals			
	Copper	**Lead**	**Cadmium**	**Zinc**
O. ruber	3.464	N.D	0.341	0.127
A. arabicus	4.619	N.D	0.341	0.135

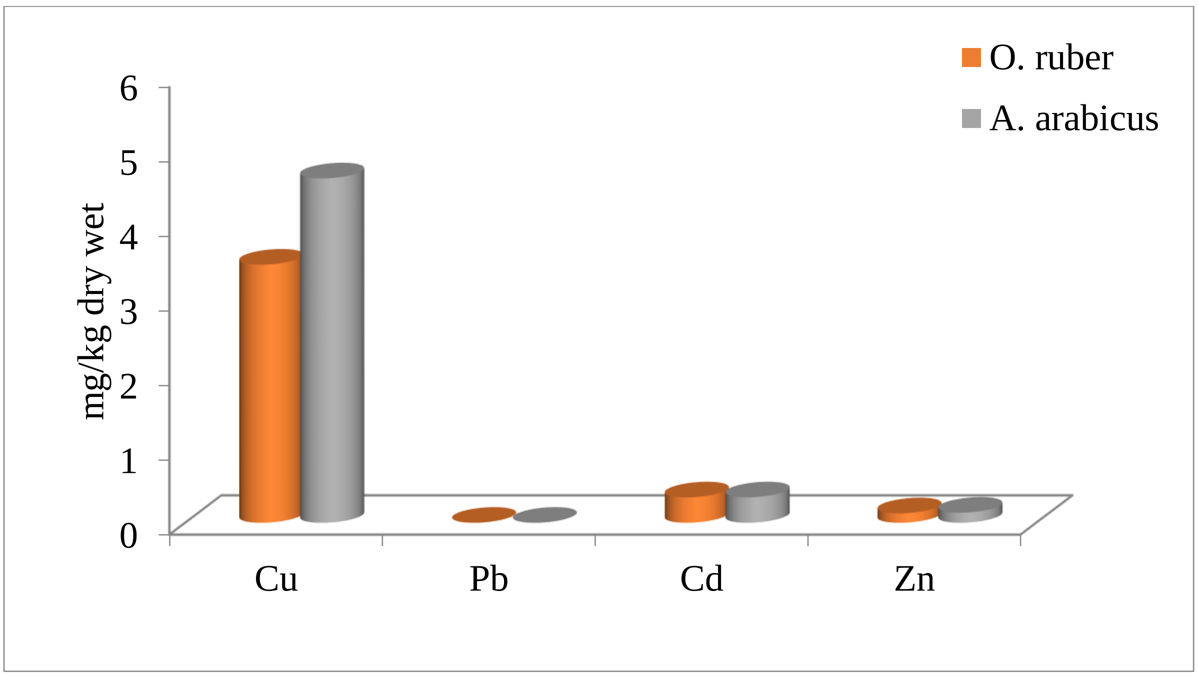

Figure (2). Concentrations of heavy metals (mg/kg dry weight) in frozen fish muscle.

Conclusions

The present study highlighted the presence of heavy metal contaminants in both fresh and frozen fish. The concentrations of Cu, Cd, and Zn varied in fish muscles, with some exceeding the allowable limits.

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تقييم مستويات العناصر الثقيلة في عينات الأسماك الطازجة والمجمدة من الأسواق المحلية في محافظة البصرة، العراق

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المستخلص

هدفت هذه الدراسة إلى تقييم مستويات المعادن الثقيلة في أنواع الأسماك المهمة اقتصاديا التي تم الحصول عليها من الأسواق المحلية في مدينة البصرة بالعراق خلال الفترة 2021-2022. تم تخزين عينات الأسماك، التي تضم *Otolithes ruber* و *Acanthoparus arabicus* ، في حاويات مبردة حتى وصولها إلى المختبر ، حيث أجريت التحاليل المختبرية .تم استخدام التحليل الطيفي للامتصاص الذري باللهب لتقدير تركيزات الرصاص والنحاس والكادميوم والزنك في أنسجة عضلات الأسماك .في عينات الأسماك الطازجة، أظهر *O. ruber* تركيزات من الرصاص والنحاس والكادميوم والزنك عند(5.774 ، N.D، 0 .013، 0.127) ملغم / كغم وزن الجاف ، على التوالي ، بينما أظهر *A. arabicus* تركيزات (5.774 ، N.D ، 0.367 ، 0.120) ملغم / كغم وزن جاف ، على التوالي .وبالنسبة للأسماك المجمدة، أظهرت *O. ruber* تركيزات(3.464 ، N.D، 0.341، 0.176) ملغم/كغم من وزن جاف، على التوالي، في حين أظهرت *A. arabicus* تركيزات (4.619 ،N.D، 0.341 ، 0.135) ملغم/كغم من وزن جاف، على التوالي .توفر هذه النتائج معلومات قيمة بشأن مستويات المعادن الثقيلة في أنواع الأسماك الطازجة والمجمدة من الأسواق المحلية في محافظة البصرة، مما يؤكد الحاجة إلى استراتيجيات المراقبة والإدارة المستمرة لضمان سلامة وجودة منتجات المأكولات البحرية التي يستهلكها السكان المحليون .

الكلمات المفتاحية : عناصر ثقيلة, أسماك الأسواق المحلية, محافظة البصرة, تقييم المخاطر