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Determination of Heavy Metals in Some Types of Imported Fish from Local Markets

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Abstract

Heavy metals can be considered in the aquatic environment as natural archaeological components and their quantities have risen as a result of industrial pollution. Heavy metals do not degrade over time and their concentrations can only rise due to bioaccumulation unlike organic contaminants. In the recent period, fish consumption has increased significantly because of its nutritional benefits, as it is a vital source of protein, as well as being high in critical vitamins and minerals. Because of the presence of heavy metals in frozen fish, it is a global public health issue concern but their presence remains essential and important for human physiological activities. However, when concentrations exceed the established allowed limits, they can be detrimental. The aim of this study was to quantify the concentration of heavy metals in frozen fish samples selected from Baghdad's local markets. Six samples (Cleaned Shrimps, Anchovy Fillets, Captain Fisher Shrimps, Mackerel Fillets, Super Fresh Kalamar Squid and Frozen Rainbow Trout) of common brands of imported fish were selected from Iraqi markets in Baghdad. Acid digestion with a mixture of (65% HNO3 with 37% HCL) was carried out to free heavy metals from fish samples to prepare solutions for testing in atomic absorption spectroscopy (AAS) device. The results reveal that the element concentrations in the selected samples (Cr, Co, Fe, Cu, Ni, K, Zn and Mg) are within the acceptable levels, and are lower than the permitted exposure limits according to international standards. It is remarkable to mention that the quantities of (Cd and Pb) are lower than permissible exposure limits of cadmium (0.2 mg/Kg) and lead (0.5 mg/Kg), implying that these imported items could be consumed safely.

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1. Introduction

Fish are the most abundant group of animals utilized in food production. Out of the 30,000 recognized species, only about 1,000 are fished commercially [1]. Its high protein content makes it a popular food all over the world [2], and for those who live near the Arabian Gulf [3]. One of the most significant difficulties that leads to reduce fish intake is environmental contamination including heavy metals [4, 5]. Toxic elements can infect fish at any stage of its growth, manufacturing, even during canning and handling [6,7].

Heavy metals cannot be digested and hence can be termed bioaccumulative in the body of an organism [8,9]. Even at low concentration, heavy metals are considered one of the most important environmental pollutants, and their presence in food is considered dangerous and one of the leading causes of food poisoning [10,11]. The World Health Organization (WHO) developed the provisional tolerable weekly intake (PWTI) as a reference value [12].

Heavy metals, unlike organic pollutants, do not dissolve over time, and their concentrations might rise due to bio-accumulation. Toxic metals include lead, arsenic, cadmium, and mercury [13,14]. These metals play a minor role in organ function, yet they are hazardous even at low quantities [15,16]. Even for bio-important metals such as chromium, zinc and nickel [17], dietary intake must be managed within regulatory limits, the excesses can cause poisoning or toxicity [16]. The main metal pollutants transported into the aquatic system include weathering of soil and rocks, human activities such as mining processing and volcanic eruptions [18]. Inhalation (breathing), ingestion (drinking or eating), and working with or near these metals are the main routs of exposure [19].

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When these poisons enter and collect in the living tissues of the body faster than the body's detoxification mechanisms, a progressive build-up occurs [20]. Exposure to high concentration of heavy metals produces poisoning of the tissues of the body, which sometimes exceed permissible concentration [21]. Foods contaminated with heavy metals can weaken immune system, slow growth, impair psychosocial capacities and increase malnutrition-related deficiencies, all of which can lead to advanced stages of upper gastrointestinal cancer [22-24]. Long-term exposure to heavy metals as lead, zinc, cadmium, copper and nickel can cause fatal health problems in humans [25]. These heavy metals have long biological half-lives and the ability to store in numerous organs of the human body, resulting annoying side effects [26-28]. Researchers have completed many scientific papers in this regard, which can be viewed for further information [29-31].

2. Experimental Part

2.1. Sampling:

Six samples of common imported frozen fishes we select from local markets in Baghdad (Cleaned Shrimps, Anchovy Fillets, Super Fresh Kalamar Squid and Frozen Rainbow Trout from Turkey), (Shrimps from India) and (Mackerel Fillets from Norway) as shown in table-1and Figures 1-6.

Table 1. The selected frozen fish's samples.

Sample No.	Fish Type	Origin Country
1	Cleaned Shrimps	Turkey
2	Anchovy Fillets	Turkey
3	Shrimps	India
4	Mackerel Fillets	Norway
5	Super Fresh Kalamar Squid	Turkey
6	Frozen Rainbow Trout	Turkey

Figure 1. Cleaned shrimps.

Figure 2. Anchovy fillets.

Figure 3. Shrimps.

Figure 4. Mackerel fillets.

Figure 5. Super fresh kalamar squid.

Figure 6. Frozen rainbow trout.

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2.2 Reagents and chemicals:

Nitric acid analytical grade (Sigma Aldrich, 65 %,) and hydrochloric acid (Sigma Aldrich, 37 %) were used to prepare samples for atomic absorption analysis. Magnesium, Zinc, Copper, Potassium, Nickel, Cobalt, Chromium, Cadmium, Iron and Lead calibration solutions are available as standard solution which prepared from 1000 mg/l standard stock solution of GFS Fishers' AAS reference standard. Deionized water used to prepare all the solutions.

2.3 Water drying:

A 1.19 g, 1.50 g, 2.00 g, 2.04, 2.00 and 2.01 g of the selected samples 1, 2, 3, 4, 5 and 6 respectively were placed separately into 200 ml beakers. Drying the fish samples from water to constant weight by placed the beakers in electrical oven at 100 ^{o}C.

2.4 Acid digestion:

A 0.85 g, 0.77 g, 1.22 g, 0.91, 0.80 and 0.91 g of the selected dry samples 1, 2, 3, 4, 5 and 6 respectively were placed separately into 200ml beakers. A 6ml of 65% HNO_3 with 4 ml of 37 % HCL was added [32]. Stirring thoroughly to mix the contents. The contents were heated until they dissolved, then Whatman filter paper No.41was used for filtration. Dilute the filtrated solution to 100ml with deionized water. The resultant solution was used to determine various metal analyses using spectrophotometry. A fume hood was used to carry out this procedure according to safety rules in chemical laboratory.

2.5 Atomic absorption spectrophotometry (AAS) analysis:

Atomic Absorption Spectrophotometry (AAS) Agilent model FS240 was used for heavy metals concentration determination in the previously acid digested frozen fish samples.

3. Results and Discussion

The prepared solutions that explained in section 2, they were tested using atomic absorption apparatus (see Tables 2 and 3).

Table 2. Some prepared samples with a brief description.

Sample No.	Sample description	Extracted solution (ml)
1	Cleaned shrimps	100
2	Anchovy fillets	100
3	Shrimps	100
4	Mackerel fillets	100
5	Super fresh kalamar squid	100
6	Frozen rainbow trout	100

Table 3. Concentration of selected elements in mg/kg (ppm) for some prepared samples.

Sample No.	Zn	Pb	Cd	Fe	Mg	Cu	K	Cr	Ni	Co
1	45.23	ND	ND	27.55	6.02	1.25	2.33	1.32	ND	6.25
2	33.20	ND	ND	55.32	16.03	3.58	11.70	2.05	2.36	3.20
3	40.01	ND	ND	15.75	27.19	6.32	8.33	2.36	1.00	8.22
4	14.26	ND	ND	69.27	24.62	1.69	5.00	7.08	8.45	7.24
5	23.06	ND	ND	33.45	21.89	4.02	17.98	6.25	3.69	6.28
6	16.98	ND	ND	40.02	26.40	2.06	5.80	3.14	5.25	1.98

ND = Not Detected.

Heavy metals are divided into two categories based on their roles in biological systems: essential and non-essential. Heavy metals are necessary for living organisms and may be required in very low amounts for the human body. Whereas heavy metals with no recognized biological function in living beings are known as non-essential. (Mg, Fe, Cu, K, Cr, Ni, Co, and Zn) are examples of necessary heavy metals that become poisonous only when a concentration limit is surpassed. Heavy metals (Cd and Pb), have an unknown biological system, are toxic and considered biologically nonessential in the human body [33-35]. Figures 7-12 shows the amount of tested heavy metals in (mg/kg) for the selected samples 1, 2, 3, 4, 5 and 6 respectively compared with the permissible exposure limit for the tested metals [36-40].

The concentrations of tested metals in (mg/Kg) for the selected samples 1, 2, 3, 4, 5 and 6 are shown in Figures 7-12 in comparison to the allowed exposure limit for the tested metals [36-40].Similar results for tobacco tests can be found in the Iraqi markets as part of the researcher's findings in this regard [41].

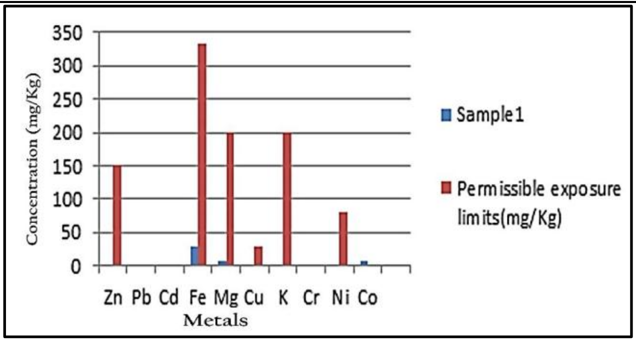

Figure 7. Concentration of tested metals compared with permissible exposure limit for sample-1.

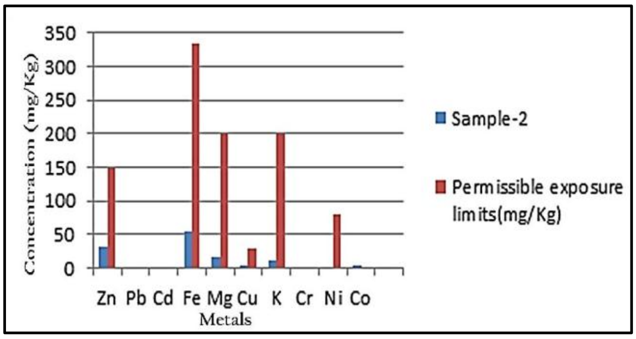

Figure 8. Concentration of tested metals compared with permissible exposure limit for sample-2.

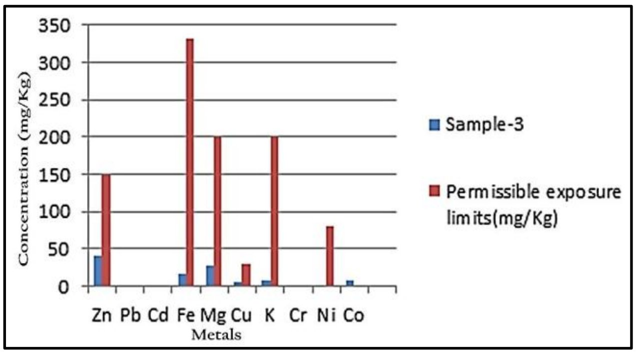

Figure 9. Concentration of tested metals compared with permissible exposure limit for sample-3.

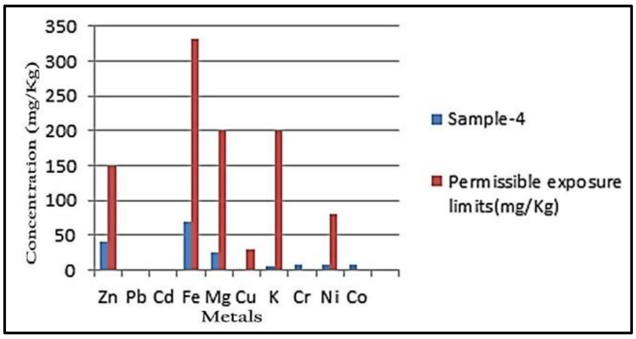

Figure 10. Concentration of tested metals compared with permissible exposure limit for sample-4.

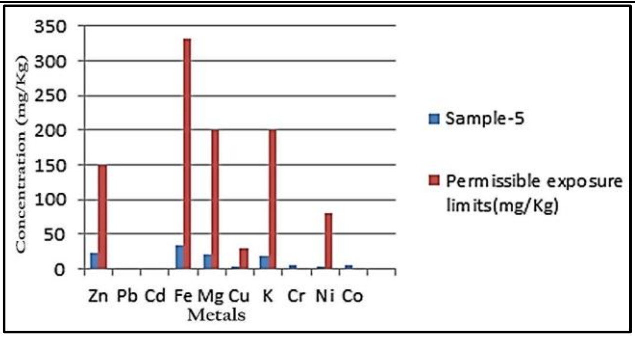

Figure 11. Concentration of tested metals compared with permissible exposure limit for sample-5.

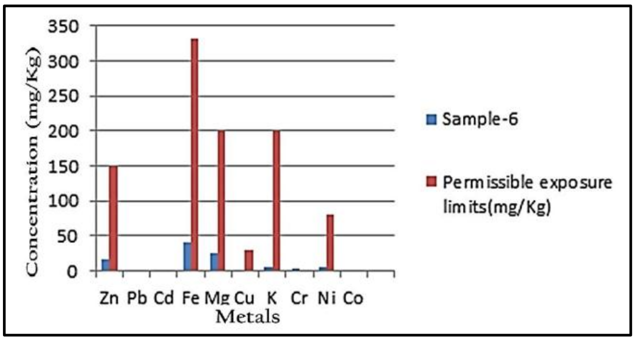

Figure 12. Concentration of tested metals compared with permissible exposure limit for sample-6.

Metals concentration obtained for elements (Mg, Fe, Cu, K, Cr, Ni, Co and Zn) found for the six samples selected from the Iraqi markets reveal that these metals are within the acceptable ranges, and that they are lower than the permitted exposure limits according to international standards. More crucially, no heavy metals (Cd and Pb) were detected within the limits of the test with a scale of (mg/Kg) compared with the allowed worldwide amounts of cadmium (0.2 mg/Kg) and lead (0.5 mg/Kg) [39], implying that these imported goods could be consumed safely.

4. Conclusion

Fish, whether local or important, is an essential food source. Six different samples of frozen fish were selected and a test of element concentrations was undertaken to identify the nature of the components contained in some selected samples of frozen fish from Iraqi markets, proving that the samples were free of harmful elements such as lead and cadmium. The values for the remaining elements (Mg, Fe, Cu, K, Cr, Ni, Co, and Zn) came in under the internationally acceptable levels. The samples that were examined are perfectly safe for human consumption as food.

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Conflicts of Interest

The authors declare that there is no conflict of interest.

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