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Journal of Natural and Applied Sciences Pakistan

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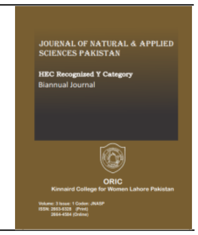

HEAVY METALS ASSESSMENT OF IMPORTED CLUPEA HARENGUS SOLD BY COLD-ROOMS IN LAGOS STATE OF NIGERIA

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Keywords
Working Children, Health and Safety, Hazardous Environment, Working Conditions, Environmental Health, Safety risk.

Abstract

This study investigated the heavy metals concentration in imported fish (Clupea harengus) obtained from cold rooms in Lagos, Nigeria. The heavy metals concentration was determined using Atomic Absorption Spectrophotometer. Chromium was present in all thirteen samples within the range of 0.005 to 0.085 mg/kg. The highest chromium concentration (0.085 mg/kg) was recorded in CHS5 while CHS10 had the lowest (0.005 mg/kg) chromium concentration. Cobalt was present in eight samples within 0.001 to 0.01 mg/kg. The highest value (0.01 mg/kg) was recorded in CHS11 while CHS4 and CHS7 had the lowest (0.001 mg/kg) cobalt concentration. Arsenic was present in six samples within 0.001 to 0.0095 mg/kg. The highest (0.0095 mg/kg) concentration was recorded in CHS9 and CHS5 had the lowest (0.001 mg/kg) chromium concentration. Lead concentration ranges from 0.006 to 0.061 mg/kg. The highest level (0.061 mg/kg) was recorded in CHS11 and CHS10 had the lowest (0.006 mg/kg) lead concentration. This research shows the need for the government agency to ascertain the heavy metals concentration in imported fish samples at the port before certifying them safe for consumption.

1. Introduction

Heavy metal pollution from agricultural, geochemical, and industrial wastes has increased due to intensive urbanization and industrial activity. The public water supply and fish consumers are at risk from heavy metal pollution of water bodies (Uysal *et al*., 2009; Okunade *et al*., 2022). Due to their persistent presence in the environment, many toxic metals accumulate in the food chain and pose significant dangers to humans when consumed (Baharom & Ishak, 2015). Fish makes up about 42% of the protein intake in Nigerians' diets and is high in vitamin B12, polyunsaturated fatty acids, and amino acids (Emmanuel *et al*., 2020). Given that most Nigerians cannot afford the price of meat, fish serves as a complement protein in daily food intake (Atta *et al*., 1997). According to studies, persons who eat fish regularly have a lower risk of developing cancer, high blood pressure, and coronary heart disease. On the other hand, fish can occasionally be contaminated and may contain small levels of highly hazardous heavy metals. The aquatic ecosphere equilibrium is known to be altered by the accumulation of pollution like heavy metals in water, and even when the level of pollution is low, accumulation and magnification can result in hazardous levels of these metals in fish and other biota in water bodies (Aderinola *et al*., 2009).

Since fish and other aquatic meals can concentrate heavy metals in their flesh and are essential to human nutrition, they must be thoroughly screened to prevent unnecessarily high levels of some inorganic and organic contaminants from being ingested by people (Oladimeji *et al*., 2013). According to earlier studies, industrial and home effluent are industrial and home effluent sources of heavy metals that contribute to the rising metallic pollution in global aquatic and terrestrial environments (Adeniyi & Yusuf 2007). Therefore, research on the bioaccumulation of contaminants in fish is crucial for establishing the varied trace metal contents in fish samples based on bio-magnifications of food chains, metabolic capacity, and eating behaviors (Adeosun *et al*., 2015). This gives an in-depth knowledge of the harmful effects of metals on aquatic ecosystems. Some researchers have reported on surveys on the presence of heavy metals in fish in Nigeria (Asuquo *et al*., 2004). One of the species of fish with the largest global abundance is the Atlantic herring (*Clupea harengus*). They can weigh up to 1.2 kilograms and attain a maximum length of 48 centimetres. It is one of the economically affordable and abundant freshwater fish species. In the human diet, Clupea harengus is an excellent source of protein (up to 79%). *Clupea harengus* is a popular fish among Nigerians, locally referred to as *sawa* in the country's southwestern part (Adeyemi *et al*., 2015).

Heavy metal pollution of aquatic life is now a global issue due to its irreversible, potentially lethal effects on humans when taken (Malik *et al*., 2010). In the last fifteen years, there has been a significant increase in investigations on heavy metals in fish. Fish have high lineages and are an essential food supply; hence, they are frequently utilized as markers of heavy metal contamination in the aquatic environment. Numerous studies have been conducted in numerous countries on evaluating heavy metal deposits in fish and their impact on consumer health. Heavy metals like chromium, cobalt, arsenic, and lead can bio accumulate to hazardous levels if consumed continuously. This study investigated the concentration of heavy metals (chromium, cobalt, arsenic, and lead) in some selected imported fish sold by cold rooms in Lagos state, Nigeria.

2. Materials and Methods

2.1. Study Area and Collection of Sample

Six (6) different sample locations were chosen in the South Western geopolitical region of the Federal Republic of Nigeria. One of the sample sites was Mushin, with a (latitude of 6.5352° N and a longitude of 3.3490° E). Ojota, with a (latitude of 6.5873° N and a longitude of 3.3786°E). Ikeja, with a (latitude of 6.6018° N and a longitude of 3.3515° E). Oshodi, with a (latitude of 6.5355° N and a longitude of 3.3087° E). Yaba, with a (latitude of 6.5095° N and a longitude of 3.3711° E). Toll Gate, with a (latitude of 6.6857°N and a longitude of 3.2602°E). Thirteen (13) fish samples (*Clupea harengus*) were collected from these thirteen (13) different cold rooms in six (6) locations in Lagos state.

Figure 1: Map of Lagos State showing sample area. (Source: Google map)

Table 1: Sample Location and Identification

Sample Code	Point of Collection	Cold Room	Country of Import
CHS^{1}	Mushin	Pescado	Russia
CHS^{2}	Mushin	Moscom	Russia
CHS^{3}	Oshodi	Seawave	Netherland
CHS^{4}	Oshodi	Taye & Kehinde	Russia
CHS^{5}	Iddo	M. Abiodun	Russia
CHS^{6}	Iddo	D one	Russia
CHS^{7}	Iddo	One love	Russia
CHS^{8}	Ojota	Metron	Uk
CHS^{9}	Ojota	FFF	Russia
CHS^{10}	Ojota	Sea gold	Atlantic
CHS^{11}	Abule egba	Progress sea food	Russia

CHS[12]	Toll gate	Kollignton	Russia
CHS[13]	Toll gate	Shellab	Russia

Key: Clupea harengus Sample[1-13] (CHS[1-13])

2.2. Wet Digestion

The methods by (Awofolu *et al*., 2005; Usero *et al*., 1997) were modified for the digestion. Three (3) grams of the samples were weighed into a 250 mL conical flask, and 20 mL of hot acid (HNO_3) was added. The conical flask was placed on a heater in the fume cupboard, starting with low heat for 30 minutes. After 30 minutes, the heat was increased to medium heat for 15 minutes and finally at high temperature until complete digestion was obtained. The flasks were rotated until the digestion was clear, giving out white fumes. The digested samples were allowed to cool and filtered to remove any residue. The filtrate was diluted to 100 mL and stored in a volumetric flask for further analysis (Adeniyi *et al*., 2004).

2.3 Determination of Heavy Metals

The determination of heavy metals was done using Buck model 210 Atomic Absorption Spectrophotometer. The digested sample was analyzed in triplicate with the instrument's metal concentration displayed in mg/kg. The heavy metals of interest were Arsenic (As), Chromium (Cr), Cobalt (Co), and Lead (Pb).

Table 2: Maximum Permissible Level of Some Heavy Metals

Heavy Metals	WHO Standard (mg/kg)	FAO Standard (mg/kg)	USEPA Standard (mg/kg)
Arsenic (As)	0.01	0.01	0.05
Chromium (Cr)	0.05	0.05	0.05
Cobalt (Co)	0.01	0.01	----
Lead (Pb)	0.05	0.05	0.05

WHO = World Health Organization Standard

FAO = Food and Agriculture Organization Standard

USEPA = United State Environmental Protection Agency Standard

3. Results and Discussions

3.1. Chromium (Cr)

Chromium was present in all thirteen samples, ranges from 0.005 to 0.085 mg/kg. The highest (0.085 mg/kg) concentration was recorded in CHS[5] sold by M. Abiodun cold room in Iddo and imported from Russia. In comparison, CHS[10] sold by Sea Gold cold room in Ojota and imported from the Atlantic had the lowest (0.005 mg/kg) chromium concentration. CHS[5] sold by M. Abiodun cold room and CHS[13] sold by Shellab cold room had 0.085 and 0.051 mg/kg, respectively, which is above the maximum permissible level (0.05 mg/kg) recommended by (World Health Organization, 2003).

The results obtained in this study are in accordance with the 0.11 and 0.054 mg/kg obtained by (Kuton *et al*., 2021) in the liver and intestine of *Malapterurus electricus*. According to research, chromium intake above the maximum approved limit recommended by the world health organization can decrease insulin sensitivity and harm the liver or kidney. Additionally, it may reduce the effectiveness of some treatments, such as anti-inflammatory drugs and pain relievers like paracetamol and ibuprofen (Aslam & Yousafzai, 2017; Hoof & San, 1981).

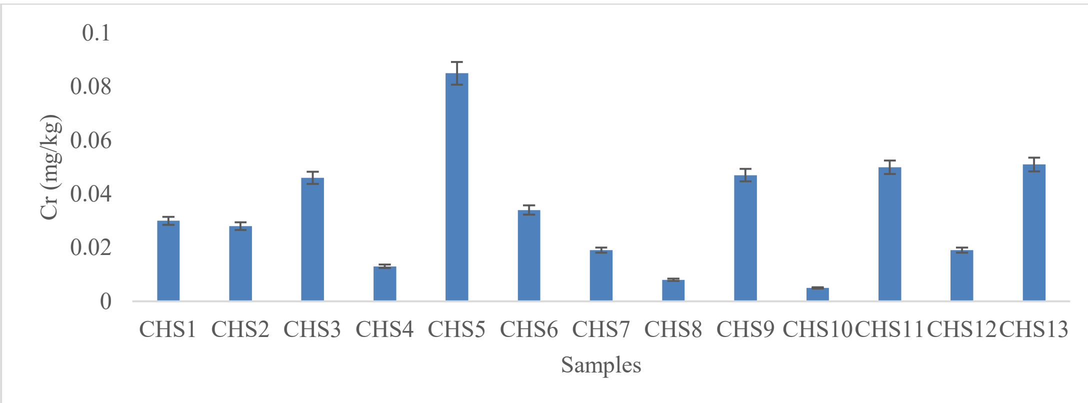

Figure 2: Chromium Concentration in *Clupea harengus Sample*[1-13] (CHS[1-13])

3.2. Cobalt (Co)

Cobalt was present in eight samples (CHS[1], CHS[2], CHS[4], CHS[5], CHS[7], CHS[9], CHS[11], and CHS[13]) ranges from 0.001 to 0.01 mg/kg. The highest (0.01 mg/kg) concentration was recorded in CHS[11] sold by Progress seafood cold room in Abule egba and imported from Russia. In comparison, CHS[4] and CHS[7] sold by Taye & Kehinde and One love cold room had the lowest (0.001 mg/kg) cobalt concentration. None of the results obtained in this study is above the maximum permissible level (0.01 mg/kg) recommended by (World Health Organization, 2003) for cobalt concentration. Cobalt is a toxic metal that, when exposed to a level higher than the permissible concentration (0.01 mg/kg), can lead to poisonous cardiomyopathy, a condition of the heart muscles. In addition, an excess of cobalt may manifest as polycythemia, degenerating into heart failure. Excessive intake of cobalt can also reduce the thyroid's activities and may lead to goitre (Taiwo *et al*., 2017).

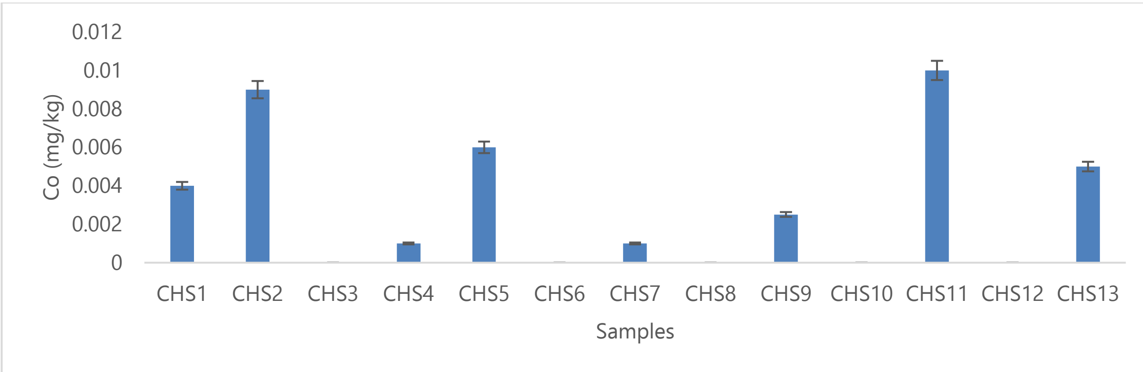

Figure 3: Cobalt Concentration in *Clupea harengus Sample*$^{1-13}$ (CHS$^{1-13}$)

3.3. Arsenic (As)

Arsenic was present in six samples (CHS^{1}, CHS^{5}, CHS^{8}, CHS^{9}, CHS^{11}, and CHS^{12}), ranges from 0.001 to 0.0095 mg/kg. The highest (0.0095 mg/kg) concentration was recorded in CHS^{9} sold by FFF cold room in Ojota and imported from Russia. In comparison, CHS^{5} and CHS^{8} sold by M. Abiodun and Metron cold room in Ojota had the lowest (0.001 mg/kg) chromium concentration. None of the results obtained in this study is above the maximum permissible level (0.01 mg/kg) recommended by (World Health Organization, 2003) for arsenic concentration. The results obtained in this study are lower than 0.018 mg/kg reported by (Akpanyung *et al*., 2014) in the kidney of *Chrysichthys nigrodigitatus*. Arsenic in human nutrition can cause skin lesions and cancer when accumulated in the body over a long period. Diabetes and cardiovascular disease have reportedly been linked [22]. Exposure during pregnancy and in young children may cause impaired cognitive development and increase children's mortality (Olmedo et al., 2013).

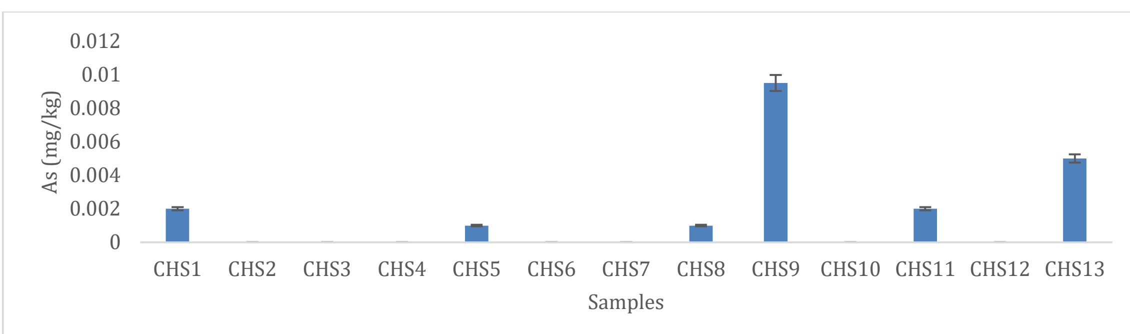

Figure 4: Arsenic Concentration in *Clupea harengus Sample*$^{1-13}$ (CHS$^{1-13}$)

3.4. Lead (Pb)

Lead was present in eleven samples (CHS^{1}, CHS^{2}, CHS^{3}, CHS^{5}, CHS^{6}, CHS^{7}, CHS^{8}, CHS^{9}, CHS^{10}, CHS^{11}, and CHS^{13}), while lead was not detected in CHS^{4} and CHS^{12}. Lead concentration ranges from 0.006 to 0.061 mg/kg. The highest (0.061 mg/kg) concentration was recorded in CHS^{11} sold by Progress seafood cold room in

Abule egba and imported from Russia. In comparison, CHS[10] sold by Sea gold cold room in Ojota had the lowest (0.006 mg/kg) lead concentration. CHS[11] sold by Progress seafood cold room in Abule egba had a value which is above the maximum permissible level (0.05 mg/kg) recommended by (World Health Organization, 2003). The results obtained in this study are lower than 0.15 and 0.27 mg/kg reported by Aderinola *et al.* (2012) for *Chrysichthys nigrodigitatus* and *Oreochromis niloticus*, respectively. Lead accumulation in the human body can cause anemia, damage or weaken the brain and kidneys, and cause anemia (Sobha *et al*., 2007). Lead bioaccumulation can cause severe health condition. Lead can also be transferred through the placental to unborn babies, thereby causing pregnant women endangering the health of the fetus. The developing neurological system of a fetus can be affected by lead (Andreji *et al*., 2006; Iromini *et al.*, 2022).

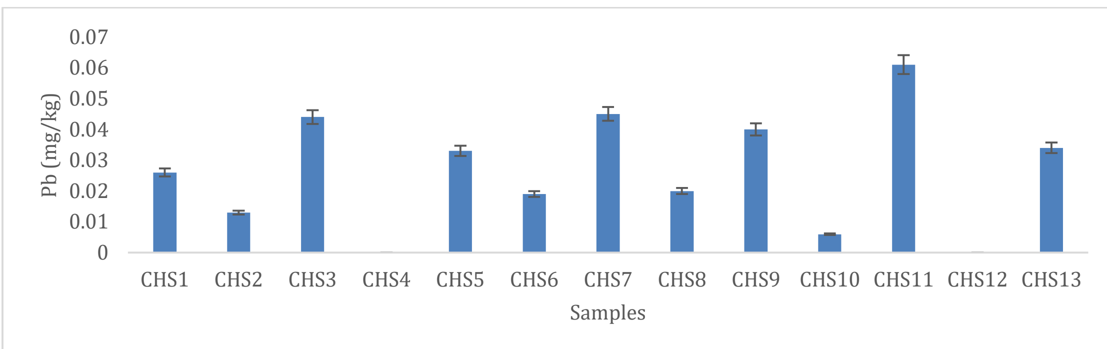

Figure 5: Lead Concentration in *Clupea harengus Sample[1-13]* (CHS[1-13])

4. Conclusion

Heavy metals, chromium (Cr), cobalt (Co), arsenic (As), and Lead (Pb) were detected *in Clupea harengus* samples obtained from cold rooms in Lagos. Their concentrations vary from low to high, CHS[5] and CHS[13] had chromium concentrations above the maximum approved limit, and CHS[11] had lead concentrations above the maximum approved limit. Although the polluted fishes are most likely contaminated from the countries of import, it is important to investigate the heavy metal concentration in imported fish from the port to ascertain the safety when consumed.

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