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Heavy Metals Analysis of Imported Atlantic Mackerel *(Scomber scombrus)* Sold by Cold-Rooms in Lagos State of Nigeria

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Abstract

This research aimed at assessing the heavy metals concentration in imported atlantic mackerel (*Scomber scombrus)* fish samples purchased from cold rooms in Lagos, Nigeria. The samples were digested using the wet digestion method, and the concentration of Chromium (Cr), Arsenic (As), Lead (Pb), and Cobalt (Co) were determined using Atomic Absorption Spectrophotometer. Chromium (Cr) was present in twelve *Scomber scombrus* samples, and the level ranged from 0.004 to 0.046 mg/kg, while arsenic (As) was present in seven fish samples, with concentrations varying within 0.001 to 0.006 mg/kg. Lead (Pb) was present in eleven samples and not detected in SS^5 and SS^7. The concentration ranged from 0.004 to 0.062 mg/kg. Cobalt (Co) was present in seven *Scomber scombrus* samples, the level ranged from 0.004 to 0.046 mg/kg. However, SS^3, SS^{10}, and SS^{13} had lead concentrations above the maximum permissible limit (0.05 mg/kg) recommended by WHO/FAO. This study established the need for Nigerian agencies in charge of food to verify, check and ascertain the safety of imported fish before endorsing them as harmless for citizens' consumption.

Keywords: Heavy metals analysis, Contamination, Scomber scombrus, Cold-rooms, Lagos state, Nigeria.

INTRODUCTION

Over the past decades, concerns have increased over the high accumulation of pollutants in the water bodies (Kumari *et al.,* 2017). The disturbing condition of rapid economic development may cause substantial, heavy metal contamination of the aquatic environment. Manufactured operations contribute to domestic and industrial waste, which may combine to pollute bodies of water (Jenyo-Oni & Oladele, 2016). Recent research has revealed that a high heavy metal concentration will have detrimental impacts on ecological stability by affecting the variety of the water's inhabitants (Igwegbe *et al.*, 2015).

Heavy metals are found in minimal amounts in plants and animals, both naturally and anthropologically, via dissolution and weathering, as well as through domestic and industrial activities (solid, liquid, and gaseous) and agricultural activities. Metals are persistent and stable natural elements of the earth's crust that can contaminate soils and waters. They are hazardous contaminants that cause problems with accumulation (Mortuza & Al-Misned, 2015; Firnanelty *et al.,* 2022). They become poisonous by interacting with chemical substances. Geological activities, metal mining, and industrial effluent are possible sources of heavy metal contamination in many countries' aquatic ecosystems (Adewumi *et al.*, 2022). In some circumstances, heavy metals may build up to dangerous concentrations and pollute the environment. Metals cannot degrade, they are absorbed into water, soil, and aquatic life (Okunade *et al.*, 2022).

Heavy metals in water bodies is from pollution, primarily from the release of untreated effluent into waterways by several industries (Aydin *et al.*, 2015). Both natural and man-made allow easy access of heavy metals into the aquatic environment, where they are absorbed into water bodies and soil particulates and transported through aquatic organisms from one place to another. One indirect indicator of the abundance and concentration of heavy metals in the aquatic environment is the accumulation of heavy metals in the tissues of aquatic creatures (Batool *et al.,* 2023). Water and soil may accumulate metals. Metal buildup in various fish tissues can be significantly influenced by a number of variables, such as the weather and the chemical and physical characteristics of the water. Some dangerous compounds that could accumulate contaminant poisoning aquatic ecosystems is a severe environmental issue. Fishes exposed to toxic compounds may impair their immunological, neurological, endocrine, and reproductive systems (Younis *et al.,* 2015).

Metal buildup in aquatic environments immediately impacts both environment and people (Al-Misned & Golam Mortuza, 2015). People feel adverse effects from such accumulations because fish is a major source of protein in human nutrition (Emmanuel *et al.,* 2020). As one of the dominant life in the aquatic environment, fishes can accumulate heavy metals from the waters around them. Fish can absorb and retain heavy metals from the environment in their flesh and bones (Elarabany & Bahnasawy, 2019). Fishes cannot survive outside water therefore; the negative impact of these contaminants is inevitable. Fish populations are dwindling due to environmental factors that alter the survival and growth of fish in their native environments (Nwoko & Egonwa, 2015). In several countries and globally, there has been significant interest in determining heavy metal concentrations in fish samples (Okunade *et al.,* 2022).

This study is preserving the quality of fish supply and reducing any potential adverse effects on humans by examining heavy metal concentrations in imported Atlantic mackerel (*Scomber scombrus)* sold in some cold rooms in Lagos State, Nigeria, as the most popular fish consumed by Nigerians.

METHODOLOGY

Materials and Instrumentals

The materials used are conical flask, filter paper, funnel, retort stand, and the reagents are conc. HNO_3. Buck model 210 Atomic Absorption Spectrophotometer was used for the heavy metals analysis.

Study Area and Sample Collection

A total of Thirteen (13) fish (*Scomber scombrus)* samples were purchased from twelve (12) cold rooms from six (6) distinct sample locations within Lagos state (Figure 1). Mushin, located at latitude 6.5352° N and longitude 3.3490° E, Ojota, situated at latitude 6.5873° N and longitude 3.3786° E, Ikeja, located at latitude 6.6018° N and longitude 3.3515° E, Oshodi, situated at latitude 6.5355° N and longitude 3.3087° E, Yaba, located at latitude 6.5095° N and longitude 3.3711° E, were the sampling location as indicated in Table 1.

Figure 1. Map of Lagos State, Nigeria. (Source: Google map)

Table 1. Sample Identification and Location

S/N	Sample Code	Cold Room (Name)	Point of Purchased	Country of Import
1	SS^{1}	Metron	Ojota	Uk
2	SS^{2}	FFF	Ojota	Russia
3	SS^{3}	FFF	Ojota	Russia
4	SS^{4}	Sea gold	Ojota	Atlantic
5	SS^{5}	Progress seafood	Abule egba	Netherland
6	SS^{6}	Kollignton	Tollgate	Norway
7	SS^{7}	Shellab	Tollgate	Russia
8	SS^{8}	Moscom	Mushin	Russia
9	SS^{9}	Seawave	Oshodi	Russia
10	SS^{10}	Taye& Kehinde	Oshodi	Uk
11	SS^{11}	M. Abiodun	Iddo	Russia
12	SS^{12}	D one	Iddo	Russia
13	SS^{13}	One love	Iddo	Korea

Note: *Scomber scombrus*$^{1\text{-}13}$ ($SS^{1\text{-}13}$)

Wet Digestion

The methods used by Okunade *et al.* (2022) and Agoro *et al.* (2020) were used in the digestion. Two (2) grams of *Scomber scombrus* samples were weighed into a conical flask, and 20 mL of conc. HNO_3 was added. The solution was heated in the fume cupboard at 50 ^oC for 30 minutes. After the temperature was increased to 100 ^oC until complete digestion was obtained. The conical flasks were revolved until the digestion was clear, releasing white fumes. The digests were allowed to cool at room temperature and filtered to remove residues. The filtrate was made up to 100 mL and kept in a flask for further analysis.

Determination of Heavy Metals

Buck model 210 Atomic Absorption Spectrophotometer was used to determine heavy metals. The digested samples were analyzed in triplicate with the instrument's metal concentration displayed in mg/kg. The heavy metals of concern in this study are chromium (Cr), arsenic (As), lead (Pb), and cobalt (Co). Table 2 shows the maximum permissible level of some heavy metals.

Table 2. Maximum permissible level of some heavy metals

Heavy Metals	FAO Standard (mg/kg)	WHO Standard (mg/kg)	USEPA Standard (mg/kg)
Lead (Pb)	0.05	0.05	0.05
Arsenic (As)	0.01	0.0	0.05
Cobalt (Co)	0.01	0.01	----
Chromium (Cr)	0.05	0.0	0.05

Note: *FAO=Food and Agriculture Organization Standard*
WHO=World Health Organization Standard
USEPA=United State Environmental Protection Agency Standard

RESULTS AND DISCUSSION

Chromium (Cr)

Chromium (Cr) was present in twelve samples, and the concentration varied from 0.004 to 0.046 mg/kg (Figure 2). The highest (0.046 mg/kg) value was recorded in SS[3] purchased at FFF cold room in Ojota and imported from Russia. Likewise, SS[1] purchased at Metron cold room in Ojota and imported from the UK had the lowest (0.004 mg/kg) chromium level. Chromium was not detected in SS[5] purchased at Progress seafood, and none of the twelve samples had chromium concentration above the maximum permissible limit (0.05 mg/kg) recommended by WHO/FAO (2020).

Therefore, the chromium concentration obtained in this study is lower than the 2.33 and 3.05 mg/kg obtained by Wangboje *et al.* (2017) in *Scomber scrombrus* sold in some major markets in Benin City, Nigeria. Chromium irritates the respiratory system and can cause other serious issues when it accumulates at high concentrations in the human body. The adverse health effects of chromium exposure include eye irritation, kidney and respiratory irritation, liver damage, nose irritation, respiratory cancer, abdominal pain, occupational asthma, pulmonary congestion, edema, etc. (Yatera *et al.*, 2018).

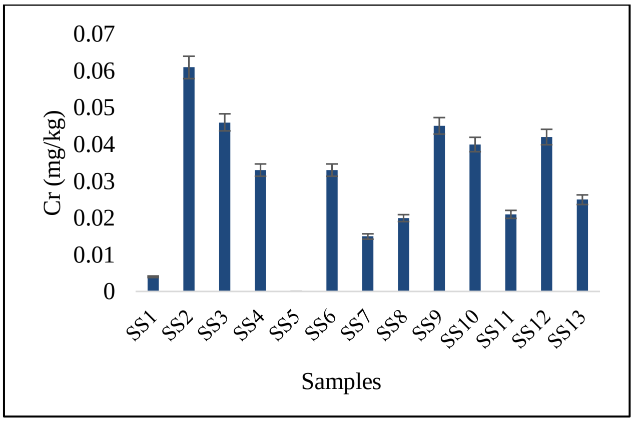

Figure 2. Chromium Concentration in *Scomber scombrus*[1-13] (SS[1-13])

Arsenic (As)

The concentration of arsenic (As) varies from 0.001 to 0.006 mg/kg (Figure 3). Arsenic was present in seven fish samples (SS[1], SS[3], SS[4], SS[6], SS[9], SS[12], and SS[13]), while it was not detected in (SS[2], SS[5], SS[7], SS[8], SS[10], and SS[11]). None of the fish samples in this study had arsenic concentration above the maximum permissible limit (0.05 mg/kg) recommended by WHO/FAO (2020). Hence, the samples in this study do not pose any threat to human health. The body's nervous, integumentary, cardiovascular, respiratory, hematopoietic, hepatic, immunological, endocrine, and reproductive systems have all been connected to health issues caused by arsenic. Arsenic can alter the body's natural epigenetic state in utero and create genetic mutations, a major contributor to cancer (Mohammed Abdul *et al.*, 2015).

Lead (Pb)

Lead (Pb) was present in eleven samples and undetected in SS[5] and SS[7]. The concentration varied from 0.004 to 0.062 mg/kg (Figure 4). The highest (0.062 mg/kg) value was recorded in SS[3] purchased at FFF cold room in Ojota and imported from Russia. Likewise, SS[11] purchased at M. Abiodun cold room from Russia had the lowest (0.004 mg/kg) lead level. SS[3], SS[10], and SS[13] had lead concentrations above the maximum permissible limit (0.05 mg/kg) recommended by WHO/FAO (2020).

Hence, there is cause for concern as this will pose serious health issues for humans. One of the most dangerous heavy metals is lead, which has no known metabolic advantages for either humans or animals. Many children's and adults' health continues to be seriously endangered by lead (Singh *et al.*, 2011; Bijang *et al.*, 2021). The effects of high lead concentration in the human body include cardiovascular, neurological, hematologic, and hormonal disorders. High levels of lead (Pb) in the blood impair the central nervous system's ability to function, which in turn causes encephalopathy that mostly targets the brain. High levels of lead in the system during pregnancy might result in miscarriage. Male libido was reported to reduce with continuous exposures (Debnath *et al.*, 2019).

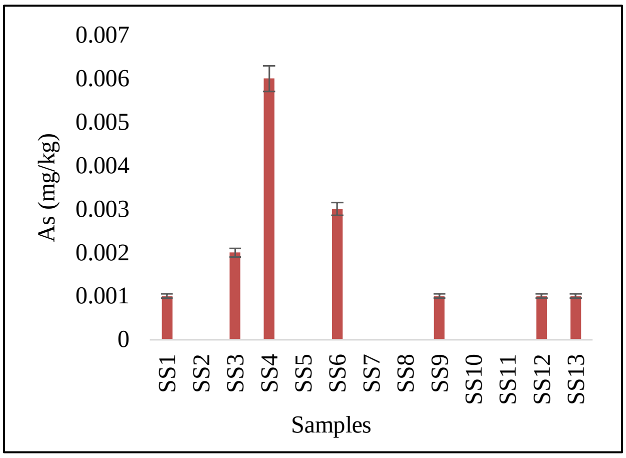

Figure 3. Arsenic Concentration in *Scomber scombrus*[1-13] (SS[1-13])

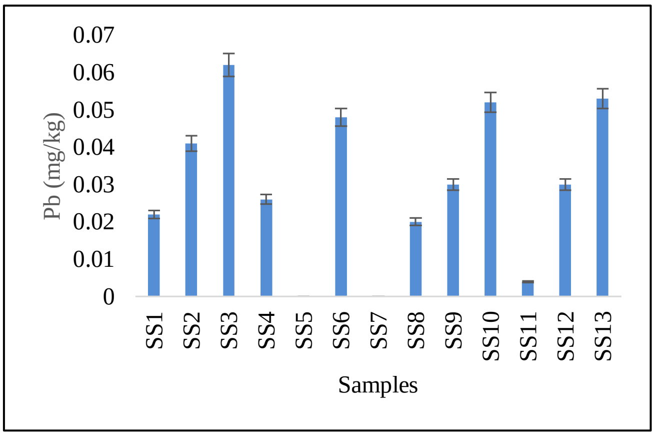

Figure 4. Lead Concentration in *Scomber scombrus*[1-13] (SS[1-13])

Cobalt (Co)

Cobalt (Co) was present in seven samples, and the concentration varied from 0.004 to 0.046 mg/kg (Figure 5). The highest (0.009 mg/kg) was recorded in SS[6] purchased at Kollignton cold room imported from Norway. Likewise, SS[4] purchased at Sea Gold cold room imported from the Atlantic had the lowest (0.002 mg/kg) cobalt level. Cobalt was not detected in SS[1], SS[5], SS[7], SS[8], SS[10], and SS[12]. None of the seven samples had cobalt concentration above the maximum permissible limit (0.01 mg/kg) recommended by WHO/FAO (2020). Excess cobalt concentration's effects on the body include vomiting and nausea. Furthermore, continuous exposure to a high concentration of cobalt can result in severe health issues, including cardiomyopathy (a disease where the heart gets large, weak, and has difficulty pumping blood) (Taiwo *et al.*, 2017).

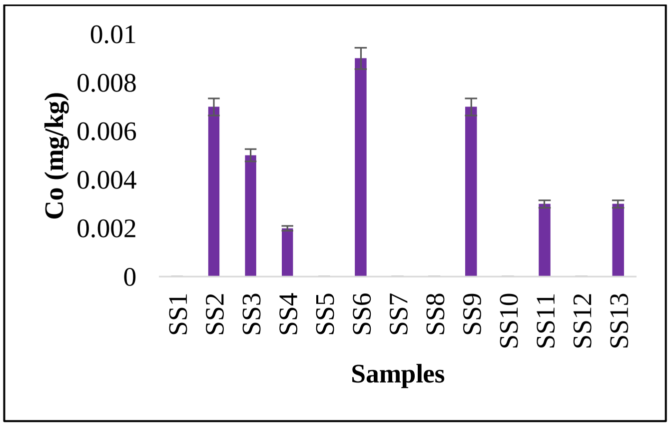

Figure 5. Cobalt Concentration in *Scomber scombrus*[1-13] (SS[1-13])

CONCLUSION

Heavy metals, chromium (Cr), arsenic (As), lead (Pb), and cobalt (Co) were detected in *Scomber scombrus* samples purchased in some selected cold rooms in Lagos. Most of the fish samples had concentrations below the maximum permissible limit. However, three samples call for serious concern as their concentration is higher than the maximum permissible limit. Therefore, Nigerian government agencies in charge of food must assess heavy metals in commercial fish before allowing it to be sold, thereby ensuring the safety of end consumers.

REFERENCES

Adewumi, A. J., Ogundele, O. D., & Adeseko, A. A. (2022). Heavy Metals in Soils around a Major Cement Factory in Southern Nigeria: Ecological and Human Health Risks. *Nigerian Journal of Environmental Sciences and Technology*, *6*(2), 283-294.

Agoro, M. A., Adeniji, A. O., Adefisoye, M. A., & Okoh, O. O. (2020). Heavy Metals in Wastewater and Sewage Sludge from Selected Municipal Treatment Plants in Eastern Cape Province, South Africa. *Water 2020*, *12*(10), 1-19

Al-Misned, F. A., & Golam Mortuza, M. (2015). Heavy Metals and Trace Elements Levels and its Risk Assessment in Two Edible Fishes from Wadi Hanifah, Riyadh, Saudi Arabia. *J. Anim.*

Plant Sci, *25*(6), 1764-1770

Aydin, H., Yürür, E. E., Uzar, S., & Küçüksezgin, F. (2015). Impact of industrial pollution on recent dinoflagellate cysts in Izmir Bay (Eastern Aegean). *Marine Pollution Bulletin*, *94*(1-2), 144-152.

Batool, M., Toqeer, M., & Shah, M. H. (2023). Assessment of water quality, trace metal pollution, source apportionment and health risks in the groundwater of Chakwal, Pakistan. *Environmental Geochemistry and Health*, *45*(7, 1-26

Bijang, C. M., Tanasale, M. F. J. D. P., Kelrey, A. G., Mansur, I. U., & Azis, T. (2021). Preparation of Natural Ouw Clay-Chitosan Composite and Its Application as Lead and Cadmium Metal Adsorbent. *Indonesian Journal of Chemical Research*, *9*(1), 15-20.

Debnath, B., Singh, W. S., & Manna, K. (2019). Sources and toxicological effects of lead on human health. *Indian Journal of Medical Specialities*, *10*(2), 66-71.

Elarabany, N., & Bahnasawy, M. (2019). Comparative and Interactive Biochemical Effects of Sub-Lethal Concentrations of Cadmium and Lead on Some Tissues of the African Catfish (Clarias gariepinus). *Toxicological Research*, *35*(3), 249-255.

Emmanuel, A. T., David, O. O., & Oyeniyi, A. T. (2020). Effects of Processing Temperature on the Proximate and Mineral Composition of Oreochromis niloticus. *International Journal of Recent Innovation in Food Science & Nutrition*, *3*(1), 1-8.

Firnanelty, F., Chadijah, S., Adawiah, S. R., Firdaus, F., & Nugraha, M. I. D. N. I. D. (2022). Analysis of the Heavy Metal Levels (Cd, Fe, Hg and Pb) at Losari Beach Tourism Reclamation of Makassar. *Indonesian Journal of Chemical Research*, *10*(2), 97-101.

Igwegbe, A. O., Negbenebor, C. A., Chibuzo, E. C., Badau, M. H., & Agbara, G. I. (2015). Effects of season and fish smoking on heavy metal contents of selected fish species from three locations in Borno State of Nigeria. *Asian Journal of Science and Technology*, *6*(2), 1010-1019

Jenyo-Oni, A., & Oladele, A. H. (2016). Heavy metals assessment in water, sediments and selected aquatic organisms in Lake Asejire, Nigeria. *European Scientific Journal*, *12*(24), 339-351.

Kumari, B., Kumar, V., Sinha, A. K., Ahsan, J., Ghosh, A. K., Wang, H., & DeBoeck, G. (2017). Toxicology of arsenic in fish and aquatic systems. *Environmental Chemistry Letters*, *15*(1), 43-64.

Mohammed Abdul, K. S., Jayasinghe, S. S., Chandana, E. P. S., Jayasumana, C., & De Silva, P. M. C. S. (2015). Arsenic and Human Health Effects: A Review. *Environmental Toxicology and Pharmacology*, *40*(3), 828-846.

Mortuza, M. G., & Al-Misned, F. A. (2015). Heavy Metal Concentration in Two Freshwater Fishes from Wadi Hanifah (Riyadh, Saudi Arabia) and Evaluation of Possible Health Hazard to Consumers. *Pakistan Journal of Zoology*, *47*(3).

Nwoko, C. O., & Egonwa, I. (2249). *Assessment of Trace Metal Contamination of Catfish (Clarias gariepinus) and Tilapia (Oreochromis niloticus) obtained from Choba and Aluu Axis of New-Calabar River, Rivers State Nigeria*. www.environmentaljournal.org

Okunade, M. B., Ogundele, O. D., Anaun, T. E., & Olulana, C. O. (2022). Heavy Metals Assessment Of Imported Clupea Harengus Sold By Cold-Rooms In Lagos State Of Nigeria. *Journal of Natural and Applied Sciences Pakistan*, *4*(2), 2022-1027.

Okunade, M., Ogundele, O., Anaun, T., & Afolabi, A. (2022). Heavy Metals Assessment of Fish Samples Obtained from Selected Cold-Rooms in Ondo State of Nigeria. *Achievers Journal of Scientific Research*, *4*(1), 1-10.

Singh, R., Gautam, N., Mishra, A., & Gupta, R. (2011). Heavy Metals and Living Systems: An Overview. *Indian Journal of Pharmacology*, *43*(3), 246-253.

Taiwo, I. O., Olopade, O. A., & Adeniyi, B. T. (2017). Assessment of Heavy Metal Concentrations in The Muscles of Ten Commercial Fish Species from Lagos Lagoon, Nigeria *Nigerian Journal of Animal Production*, *44*(3), 140-151.

Wangboje, O. M., Akaehomen, S., & Erhayimwen, M. (2017). Human Health Risk Assessment in Relation to Heavy Metals in The Atlantic Mackerel (Scomber scrombrus, L. 1758) Sold in Some Major Markets in Benin City, Nigeria. *Tropical Journal of Natural Product Research*, *1*(1), 32-38.

World Health Organization. (2020). Diet, Nutrition and The Prevention of Chronic Diseases: Report of A Joint WHO/FAO Expert Consultation. 2003. *WHO Technical Report Series*, (916).

Yatera, K., Morimoto, Y., Ueno, S., Noguchi, S., Kawaguchi, T., Tanaka, F., Suzuki, H., &

Higashi, T. (2018). Cancer Risks of Hexavalent Chromium in the Respiratory Tract. *Journal of UOEH*, *40*(2), 157-172.

Younis, E. M., Al-Asgah, N. A., Abdel-Warith, A. W. A., & Al-Mutairi, A. A. (2015). Seasonal Variations in The Body Composition and Bioaccumulation of Heavy Metals in Nile Tilapia Collected from Drainage Canals in Al-Ahsa, Saudi Arabia. *Saudi Journal of Biological Sciences*, *22*(4), 443-447.