Determination of Potentially Toxic Metals in Some Selected Sea Foods Sold in Enugu State, Nigeria

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***Abstract*: Seafood is a vital source of protein, but contamination with toxic metals poses significant health risks. This study analyzed the presence of lead (Pb), cadmium (Cd), mercury (Hg), and arsenic (As) in commonly consumed seafood stock fish, singi fish, panda fish, and crayfish purchased from Ogbete Market, Enugu State. The results revealed that Pb levels were high across all samples, exceeding safety limits, while Hg was only detected in stock fish but remained within permissible levels. Cd was absent in panda fish and crayfish but surpassed regulatory thresholds in stock fish (0.344 mg/L) and singi fish (0.110 mg/L). Arsenic was found in all samples but remained within safe limits. The accumulation of these metals in seafood raises serious health concerns, as prolonged consumption can lead to neurological disorders, kidney damage, and cardiovascular diseases. Given the bioaccumulative nature of these toxins, urgent measures are required to regulate metal contamination in fish. This study recommends stringent monitoring of fish feeds, routine quality assessments of farmed seafood, and the enforcement of environmental policies to prevent industrial and agricultural pollutants from contaminating aquatic ecosystems. Ensuring the safety of seafood is critical to public health, and immediate intervention is necessary to mitigate long-term risks associated with toxic metal exposure.**

***Keywords*: Toxic metals, Seafood contamination, Bioaccumulation, Public health, Heavy metal toxicity, Food safety.**

1. Introduction

The word "potentially" means something that could happen or develop in the future. Its opposite is "actually," which refers to something that is already happening. If we start calling all toxic substances "potentially toxic," it could create confusion between things that are truly harmful and those that only have the possibility of being harmful (1).

Some experts argue that using the term “potentially toxic elements” instead of "heavy metals" helps avoid unnecessary fear (5). They believe the word "heavy" makes people automatically associate metals with danger, even when not all of them are harmful. They suggest educating the public to stop using the term “heavy metals,” especially in government reports or non-scientific discussions (5,3). However, it’s important for scientists to be clear about their terminology while also being cautious about environmental risks. The goal should be to raise awareness without downplaying real dangers (2).

Seafood plays a vital role in nutrition, providing food, income, and essential nutrients. Health experts recommend eating seafood regularly, as it contains beneficial fatty acids like DHA and EPA, which help prevent chronic diseases (3). Fish can be divided into two main types: finfish (which include white fish and oily fish) and shellfish (such as mollusks and crustaceans) (6).

Unfortunately, human activities like industrial work, farming, and mining have increased the number of toxic metals in the environment, including the ocean (4). As a result, fish and other marine creatures absorb these metals, sometimes in amounts that can be harmful. Since seafood is a common food source, people can unknowingly consume these toxic metals. If seafood contains metal levels above the legal limit, it is considered unsafe for human consumption and is banned in many countries (1,3,4).

Toxic metals harm not only marine life but also humans and other animals that eat contaminated seafood. The health risks of consuming seafood with high metal content outweigh the nutritional benefits. This is why it is crucial to check the levels of heavy metals in seafood sold in Enugu State to determine whether it is safe to eat.

2. Method

Sample Collection and Preparation: Seafood samples were purchased from a local vendor at Ogbete Main Market in Enugu State. The four types of seafood selected for analysis were stockfish, singi fish, panda fish, and crayfish. These were chosen because they are the most commonly available and widely consumed seafood in the market.

To prepare the samples for testing, they were first washed with distilled water to remove any dirt or external contaminants. The samples were then left at room temperature to thaw. Once dried, the fish samples were ground into a fine powder using an electric grinder and stored in amber-colored bottles inside vacuum desiccators to prevent contamination. A specific amount of the powdered sample was weighed and heated in a furnace at 700°C for four hours to break it down for further analysis.

Digestion Process for Metal Analysis: For the detection of potentially toxic metals, 2g of each powdered sample was measured and placed into separate digestion flasks. A strong acid mixture, known as aqua regia (containing nitric acid, perchloric acid, and sulfuric acid), were added to each flask to dissolve the samples. These flasks were then heated in a fume hord until the samples were fully digested into a clear liquid.

Once digestion was complete, the samples were diluted with distilled water to a total volume of 100ml. Further dilutions were made as needed for each specific metal analysis. The final solutions were tested using an Atomic Absorption Spectrophotometer (AAS), which measures metal concentrations. The results were recorded in milligrams per liter (mg/L) and presented in a table.

3. Results

Table 1
Showing the concentration of potentially toxic potentially toxic metals in sea foods sold in enugu state

Parameters	Stock Fish	Singi Fish	Panda Fish	Crayfish
Lead (mg/L)	0.394	0.378	0.174	0.113
Cadmium(mg/L)	0.344	0.110	ND	ND
Mercury (mg/L)	0.454	ND	ND	ND
Arsenic (mg/L)	0.002	0.013	0.011	0.020

ND = Not Detected

4. Discussion

Table 1 presents the findings of toxic metal contamination in seafood samples (stockfish, singi fish, panda fish, and crayfish) sold in Enugu State. The metals analyzed in this study included lead (Pb), cadmium (Cd), mercury (Hg), and arsenic (As). The acceptable levels of toxic metals in food differ across countries, as they are based on recommendations from the World Health Organization (7) and local regulatory standards.

The results showed that stockfish had the highest concentration of lead at 0.394 mg/L, while crayfish contained the least at 0.113 mg/L. This finding aligns with those reported by Maliki and Maurya (8), who observed significant bioaccumulation of lead in fish tissues from the polluted Kali River in India, emphasizing the risk associated with consuming fish from contaminated environments. Similarly, Maurya and Malik (9) documented elevated Pb levels in Ganga River fish, highlighting the health threats posed to human consumers.

Cadmium was not detected in panda fish and crayfish, but stockfish had the highest level at 0.344 mg/L, followed by singi fish at 0.110 mg/L. These levels are higher than the FAO's recommended limit of 0.05 mg/L, reflecting patterns seen in studies such as Resma *et al*. (10) and Shaker *et al*. (11), where cadmium levels exceeded safe thresholds in both farmed and wild fish. Cadmium bioaccumulation poses a long-term health risk, especially to the kidneys, as supported by the findings of Kumari and Maiti (12).

Mercury was only found in stockfish at 0.454 mg/L, which is below the 1 mg/L limit set by the FAO. However, even at sub-threshold levels, mercury's neurotoxic effects are well documented, as shown by Monteiro *et al*. (14) in their study on the bioaccumulation of inorganic mercury in Hoplias malabaricus, where oxidative stress and tissue damage were reported. This is consistent with Kumari and Maiti (12), who emphasized the risk from chronic low-level exposure to mercury.

Arsenic was present in all samples but in small amounts, ranging from 0.002 mg/L in stockfish to 0.020 mg/L in crayfish. These values are far below the safe limits of 1 mg/L for solid foods and 0.1–0.2 mg/L for beverages. The low arsenic levels recorded in this study are reassuring, in contrast to higher concentrations reported in industrial areas like Huludao City in China, where Zheng *et al*. (14) noted significant dietary arsenic exposure through seafood.

Lead exposure, especially at the levels found in this study (above 0.1 mg/L), poses substantial health concerns. Research indicates that even low lead exposure (0.10–0.50 mg/L) can lead to learning difficulties in children and cardiovascular issues in adults (8,12). Our findings are consistent with the study by Mapenzi *et al*. (15) on Lake Rukwa fish in Tanzania, where fish from polluted zones showed elevated Pb and Cd concentrations. Similarly, Nzeve *et al*. (16) found high Pb bioaccumulation in Clarias gariepinus from the Masinga Reservoir in Kenya.

The absence of cadmium in panda fish and crayfish, and its elevated levels in stockfish and singi fish, may reflect species-specific differences in bioaccumulation, feeding habits, and habitat. This observation is consistent with Shaker *et al*. (11), who highlighted how aquaculture practices and environmental management influence metal uptake in fish.

Furthermore, studies like Darko *et al*. (17) demonstrated that sewage-fed aquaculture systems can significantly contribute to elevated metal accumulation in fish, underscoring the role of pollution sources. The relatively lower levels in crayfish and panda fish suggest these species may be harvested from less contaminated environments, or they may possess lower bioaccumulation potentials.

Toxic metals in fish serve as useful bioindicators of environmental pollution. As noted by Imlani *et al*. (18) in their study of Tawi-Tawi Bay, metal concentrations in aquatic organisms reflect the contamination status of their habitats. Similarly, Cohen *et al*. (19) showed how sediment pollution contributes to biodiversity loss and metal accumulation in fish in Lake Tanganyika.

Regular monitoring of toxic metals in seafood is essential to protect public health. This is especially important given that fish cannot efficiently excrete heavy metals like lead, mercury, and cadmium. Continuous consumption of contaminated seafood can result in cumulative toxicity in humans (14, 12).

In summary, while arsenic and mercury levels in the samples were within internationally acceptable limits, lead and cadmium levels particularly in stockfish and singi fish exceeded recommended thresholds and pose significant public health risks. These findings support previous studies conducted in India (9), Tanzania (15), and China (14), emphasizing the need for regular surveillance, better environmental regulation, and consumer awareness regarding seafood safety in Enugu and similar urban markets.

5. Conclusion

This study found that lead levels in seafood from Ogbete Market were high, while mercury and arsenic were within safe limits. Cadmium was not found in panda fish and crayfish but exceeded safe levels in stock fish and singi fish. Since these toxic metals can accumulate in the body over time and pose health risks, steps should be taken to minimize their presence. Fish feed should be carefully managed to prevent contamination, and regular monitoring of both farmed fish and their feed is necessary to ensure consumer safety. Fish farmers and buyers should use this information to promote public health by adhering to safety guidelines and conducting periodic quality checks. Authorities should enforce proper disposal and recycling of waste from farms, homes, and industries to prevent water pollution. Additionally, activities such as setting up auto repair shops near water bodies and dumping waste in rivers should be discouraged, while regular water quality assessments should be encouraged.

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