Journal of Environment, Climate, and Ecology (JECE)
ISSN: 3079-255X (Online)
Volume 2 Issue 2, (2025)
https://doi.org/10.69739/jece.v2i2.844
https://journals.stecab.com/jece

Published by
Stecab Publishing

Research Article

Bioaccumulation of Nickel, Lead, and Cadmium in Tissues of Callinectes sapidus from the Iko River, Nigeria: Implications for Human Health Risk and Environmental Safety

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About Article

Article History

Submission: June 30, 2025
Acceptance : August 03, 2025
Publication : August 07, 2025

Keywords

Callinectes Sapidus, Heavy Metals, Iko River, Risk Assessment

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ABSTRACT

This study investigated the bioaccumulation of three toxic heavy metals—nickel (Ni), lead (Pb), and cadmium (Cd)—in the tissues of *Callinectes sapidus* (blue crab) from the Iko River, a heavily industrialised estuarine system in Eastern Obolo, Akwa Ibom State, Nigeria. A total of 12 adult crabs (six males and six females) were collected over a three-week period from two locations using crawfish nets and dissected to analyse metal concentrations in the hepatopancreas, gills, and muscle. Samples were digested with HNO_3/ $HClO_4$ and analysed using Atomic Absorption Spectrophotometry (AAS), with method detection limits of 0.01 mg/kg for Ni, 0.005 mg/kg for Pb, and 0.002 mg/kg for Cd. Results revealed a hierarchical pattern of metal accumulation across tissues: hepatopancreas > gills > muscle. Female crabs exhibited significantly higher concentrations than males. At Station A, Ni concentrations in female hepatopancreas reached 312.59 ± 0.93 mg/kg, Pb 39.32 ± 0.33 mg/kg, and Cd 8.99 ± 0.07 mg/kg, all of which exceeded USEPA and FAO/WHO safety thresholds. Health risk analysis using Estimated Daily Intake (EDI) and Target Hazard Quotient (THQ) showed values far above safe limits, particularly in female tissues. THQ values ranged from 4.44–15.00 (Ni), 1.34–10.74 (Pb), and 0.12–8.70 (Cd), indicating a significant non-carcinogenic health risk to consumers. The findings demonstrate that *C. sapidus* from the Iko River is unsafe for human consumption due to chronic exposure to heavy metals, likely stemming from nearby oil-related activities and industrial discharge. Continuous environmental monitoring and regulatory enforcement are urgently recommended to protect ecosystem health and public safety.

Citation Style:

Okpoji, A. U., Emem, J. A., Ekwere, I. O., Odibo, U. E., Aleaekwe, I. O., Warder, A. B., & Eboj-Ajoku, O. I. (2025). Bioaccumulation of Nickel, Lead, and Cadmium in Tissues of Callinectes sapidus from the Iko River, Nigeria: Implications for Human Health Risk and Environmental Safety. *Journal of Environment, Climate, and Ecology, 2*(2), 29-37. https://doi.org/10.69739/jece.v2i2.844

1. INTRODUCTION

Metal pollution has become a major international issue since the 1960s s when thousands of people were poisoned in Minamata, Japan, after consuming mercury-polluted seafood (Oladimeji, 2021). Researchers have affirmed main sources of metal pollution are domestic/industrial sewage. Industrial effluents, oil and chemical spills, combustion emissions, mining operations, Metallurgical activities, and non-hazardous landfill sites (Etesin *et al.*, 2013). Heavy metal pollution is considered a serious pollutant of the aquatic environment, and this is caused by the discharge of chemicals from bunkering activities, manufacturing industries, and city waste (Anarado *et al.*, 2023). These metals are toxic, have high persistence, are non-biodegradable, and tend to bio-accumulate in organisms of aquatic environments, as a result of this circulate in the blood, accumulate in the target tissue, and cause death (Wang *et al.*, 2015).

In recent years, invertebrates have been used to evaluate metal bioaccumulation of heavy metals, and conducting this kind of study is difficult owing to the small sample sizes and in some cases multiple species. However, invertebrates are advantageous because they are relatively sedentary and represent the exposure to the site of the collection as a food source, which provides a means of transforming potentially toxic elements to higher trophic levels and thus accumulating high levels of heavy metal concentration (Peterson *et al.*, 2012). Oil-producing activities in this region are faced with several environmental issues, such as illegal oil bunkering, anthropogenic waste disposal, and intensive aquacultural activities (Again *et al.*, 2008). Oil spills are regarded as a common means of heavy metal contamination of aquatic and terrestrial environments in these oil-producing regions. Since crude oil is a complex mixture of hydrocarbon and non-hydrocarbon compounds (including heavy metals) found in subsurface deposits worldwide, oil spillage results in the release of oil into the natural environment and is associated with activities such as extraction, refining, transportation, and storage of crude oil. Therefore, this research is aimed at assessing Nickel, Lead and Cadmium in the tissue of *C. Sapidus.*

2. LITERATURE REVIEW

2.1. Trends in metal bioaccumulation in aquatic organisms

Heavy metal bioaccumulation in aquatic organisms has been widely documented due to the persistent and non-biodegradable nature of metals such as nickel (Ni), lead (Pb), and cadmium (Cd). These metals tend to accumulate in the organs of aquatic species through direct uptake from water and sediments, or indirectly via trophic transfer (Wang *et al.*, 2015). Invertebrates, particularly crustaceans like crabs, are useful bioindicators because of their sedentary nature and high susceptibility to localised contamination (Ekpo *et al.*, 2008). Among various tissues, the hepatopancreas often shows the highest levels of metal accumulation due to its role in detoxification and metabolic processing (Etesin *et al.*, 2013). Similarly, gills, being in constant contact with ambient water, also show elevated concentrations, while muscle tissues typically record the lowest levels due to their limited metal-binding capacity (Ubong *et al.*, 2023). Studies have shown that bioaccumulation follows a consistent pattern—hepatopancreas > gills > muscle—in many aquatic species including blue crabs. This hierarchy has been validated across various geographic regions and ecological conditions, indicating a common physiological mechanism of metal retention and detoxification.

2.2. Health effects of heavy metal exposure through aquatic food sources

The consumption of seafood contaminated with heavy metals poses a serious public health threat. The chronic ingestion of Ni, Pb, and Cd—even in trace amounts—has been associated with renal dysfunction, neurological disorders, reproductive toxicity, and carcinogenesis (Nsikak and Etesin, 2008). The United States Environmental Protection Agency (USEPA) and the FAO/WHO have established permissible limits for metal concentrations in food, beyond which health risks become significant. Health risk assessments often employ metrics such as Estimated Daily Intake (EDI) and Target Hazard Quotient (THQ) to quantify exposure risk (USEPA, 2006). Lead, for instance, is known for its neurotoxic and haematological impacts, especially in children and pregnant women. Cadmium disrupts calcium metabolism, leading to bone demineralisation, while nickel has been linked to dermal allergies and potential carcinogenicity (Jan *et al.*, 2010). Elevated THQ values (greater than 1) suggest that consumers of contaminated seafood are at risk of non-carcinogenic effects, while cumulative exposure may lead to long-term health consequences including cancer.

2.3. Regional studies on heavy metal contamination in the niger delta

In the Niger Delta region of Nigeria, numerous studies have identified industrial effluents, oil exploration, illegal bunkering, and urban runoff as the major sources of heavy metal contamination in aquatic ecosystems (Anarado *et al.*, 2023). The Iko River, situated in Eastern Obolo, Akwa Ibom State, is no exception. This estuarine environment is impacted by activities such as oil spills, gas flaring, and industrial discharges, which introduce heavy metals into the aquatic food chain (Etesin *et al.*, 2013). Adedokun *et al.* (2016) assessed heavy metal concentrations in vegetables sold in Lagos markets and identified significant human health risks, a trend mirrored in aquatic studies within the Niger Delta. Anarado *et al.* (2023) further demonstrated high levels of Cd, Pb, As, and Hg in blue crabs from Bayelsa State, indicating that bioaccumulation is prevalent throughout the region's aquatic systems. Ubong *et al.* (2011) corroborated these findings by linking localised pollution in the Iko River to elevated metal levels in fish and shellfish.

2.4. Sex and organ-specific accumulation patterns

Sex-specific variations in heavy metal accumulation have been observed in various crustacean species. Female organisms often exhibit higher metal concentrations than males, potentially due to increased metabolic demands during oogenesis and the presence of more lipid-rich tissues which tend to sequester lipophilic substances, including some metal compounds (UNEP, 2011). This has implications for risk assessment, as consumption of female crabs may pose a greater health risk due to their higher contaminant loads. Similarly, the tissue distribution of metals reflects the biological functions of different organs. The hepatopancreas, being central to digestion and detoxification, serves as the primary site for metal sequestration (Storelli *et al.*, 2008). Gills act as the interface for waterborne exposure, while muscle tissues serve as a proxy for direct human exposure since they are typically consumed. These differences are vital when assessing ecological and health risks associated with contaminated seafood.

2.5. Implications for risk assessment and environmental management

Risk assessments such as EDI and THQ are critical tools for determining the safety of seafood consumption. These values incorporate factors like ingestion rate, body weight, and oral reference doses to quantify human exposure. Studies such as those by Garcia-Rico *et al.* (2007) and Jan *et al.* (2010) emphasise the utility of these indices in public health planning. In the Iko River study, high THQ values observed in hepatopancreas and gills across both sampling stations suggest a considerable risk of chronic toxicity and potential carcinogenic effects, particularly for vulnerable populations. The persistent contamination of aquatic environments not only endangers human health but also threatens biodiversity and the socio-economic stability of communities reliant on fisheries. As such, continuous monitoring, enforcement of environmental regulations, and development of remediation strategies are essential to curb the bioaccumulation of heavy metals in aquatic systems.

3. METHODOLOGY

3.1. Study area

The study was conducted in the Iko River, located in Eastern Obolo Local Government Area of Akwa Ibom State, Nigeria. This estuarine ecosystem, positioned between latitudes 4°30′ and 4°45′N and longitudes 7°35′ and 7°40′E, is a critical breeding and feeding ground for several aquatic species, including Callinectes sapidus (blue crab). The river empties into the Atlantic Ocean and is heavily influenced by anthropogenic activities such as oil exploration, industrial discharges, and illegal bunkering.

3.2. Ethical consideration and validation of methods

All procedures involving the collection and handling of blue crabs complied with international ethical standards for the use of aquatic animals in environmental research. Ethical approval was obtained from the Institutional Research Ethics Committee. Quality control measures were strictly implemented during metal analysis. All reagents used were of analytical grade, and glassware was acid-washed and rinsed thoroughly with distilled water. Method validation was achieved through the use of procedural blanks, triplicate analysis, and standard reference materials (SRMs). Calibration of the Atomic Absorption Spectrophotometer (Unicam 969, Thermo Elemental) was conducted using multi-element standard solutions. Detection limits for Ni, Pb, and Cd were 0.01 mg/kg, 0.005 mg/kg, and 0.002 mg/kg respectively.

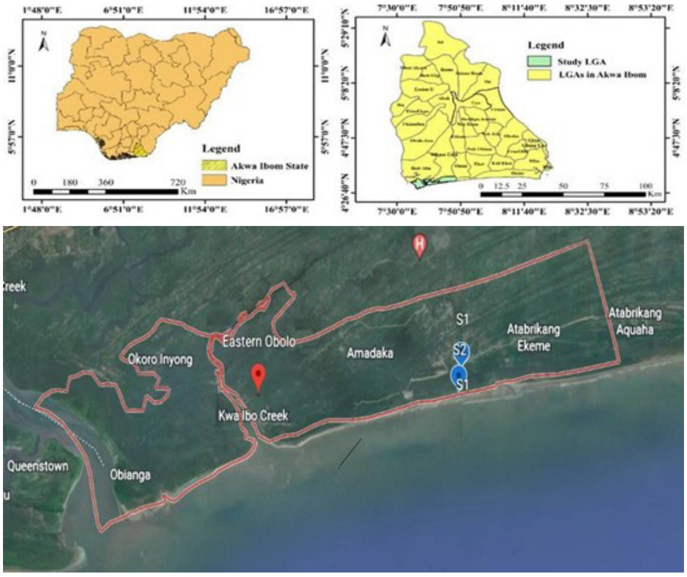

Figure 1. Map of the iko river showing the sample stations.

3.3. Sample collection and preparation

A total of 12 adult Callinectes sapidus specimens—comprising six males and six females—were collected over a three-week sampling period in July 2025 from two distinct locations (Station A and Station B) along the Iko River. At each station, three male and three female crabs were captured during daylight hours using a non-lethal crawfish net. The crabs were immediately transferred into insulated containers filled with river water and transported to the laboratory for analysis. Upon arrival, the specimens were rinsed with deionised water and dissected using sterile stainless-steel instruments. Three target tissues—hepatopancreas, gills, and muscles—were carefully excised from each crab. Each tissue sample was labelled, oven-dried for 72 hours at 60°C, and ground into a fine powder prior to digestion.

Figure 2. Female crab, Male crab

3.4. Sample digestion and heavy metal analysis

One gram (1 g) of dried tissue was digested using a mixture of 10 mL nitric acid (HNO_3, 68%) and 2 mL perchloric acid ($HClO_4$, 70%) under a fume hood on a hotplate until white fumes appeared, indicating complete digestion. The digest was cooled and diluted to 100 mL with deionised water in a volumetric flask. Heavy metal concentrations of nickel (Ni), lead (Pb), and cadmium (Cd) were determined using Atomic Absorption Spectrophotometry (AAS). All analyses were performed in triplicate, and results were expressed as mean ± standard deviation (mg/kg dry weight).

3.5. Estimated Daily Intake (EDI)

The Estimated Daily Intake (EDI) of each metal was calculated to assess the average daily exposure through crab consumption using the following formula:

$$EDI = \frac{(Cmetal \times IR \times CF)}{BW}$$

Where,

Cmetal = Concentration of metal in tissue (mg/kg)

IR = Ingestion rate (60 g/day or 0.06 kg/day)

CF = Conversion factor (20.5 for *C. sapidus*)

BW = Average body weight of adult (60 kg) (USEPA, 2006)

3.6. Target Hazard Quotient (THQ)

Non-carcinogenic risk was assessed using the Target Hazard Quotient (THQ), which was calculated following the United States Environmental Protection Agency (USEPA) methodology (USEPA, 2011). The equation is as follows:

$$THQ = \frac{EF \times ED \times IR \times C}{RfD \times BW \times AT}$$

Where,

EF = Exposure frequency (350 days/year)

ED = Exposure duration (54 years, average Nigerian lifespan)

IR = Ingestion rate (0.06 kg/day)

CCC = Metal concentration in tissue (mg/kg)

RfD = Oral reference dose (mg/kg/day)

BW = Average body weight (60 kg)

AT = Averaging time for non-carcinogens (ED × 365 days = 19,710 days). A THQ value ≥ 1 implies a potential health risk from prolonged exposure, while a value < 1 suggests negligible risk.

4. RESULTS AND DISCUSSION

4.1. Heavy metal concentration in tissues of callinectes sapidus

The concentrations of Nickel (Ni), Lead (Pb), and Cadmium (Cd) in the gills, hepatopancreas, and muscles of male and female *C. sapidus* from Stations A and B are presented in Tables 1 and 2.

Nickel exhibited the highest levels among the three metals analysed. At Station A, Ni concentrations in the hepatopancreas ranged from 230.97–231.17 mg/kg in males and 311.67–313.53 mg/kg in females. Gills showed 138.72–139.65 mg/kg (males) and 210.00–213.51 mg/kg (females), while muscles recorded the lowest concentrations: 103.86–105.02 mg/kg (males) and 168.32–170.01 mg/kg (females). Similarly, at Station B, the hepatopancreas had the highest Ni levels: 182.97–183.65 mg/kg (males) and 272.61–272.85 mg/kg (females). Gills ranged from 129.93–130.52 mg/kg (males) to 192.06–192.14 mg/kg (females), while muscle concentrations ranged from 93.09–93.33 mg/kg (males) to 165.63–165.84 mg/kg (females).

Lead concentrations followed a similar trend. At Station A, Pb levels in the hepatopancreas were 29.72–29.76 mg/kg (males) and 38.99–39.63 mg/kg (females), while gills contained 13.46–14.94 mg/kg (males) and 21.17–21.35 mg/kg (females). Muscle tissues had the lowest Pb concentrations: 3.51–3.60 mg/kg (males) and 6.29–6.32 mg/kg (females). At Station B, Pb levels in the hepatopancreas ranged from 22.86–23.15 mg/kg (males) to 37.01–37.08 mg/kg (females), with lower concentrations in the gills (10.07–10.25 mg/kg in males; 12.74–12.80 mg/kg in females) and muscles (2.73–3.02 mg/kg in males; 4.77–4.82 mg/kg in females).

Cadmium concentrations, though lower than Ni and Pb, showed a significant pattern of bioaccumulation. At Station A, Cd in the hepatopancreas ranged from 3.98–4.10 mg/kg (males) to 8.91–9.03 mg/kg (females), while gill concentrations were 0.45–1.50 mg/kg (males) and 4.43–4.95 mg/kg (females). Muscle tissues ranged from 0.26–0.35 mg/kg in males to 2.81–2.84 mg/kg in females. At Station B, Cd concentrations in the hepatopancreas ranged from 2.04–2.10 mg/kg (males) and 6.83–7.08 mg/kg (females), with gill values of 0.12–0.18 mg/kg (males) and 3.59–3.66 mg/kg (females), and muscle concentrations of 0.105–0.15 mg/kg (males) and 1.47–1.56 mg/kg (females). Across both stations, the hierarchical pattern of metal accumulation in tissues was: hepatopancreas > gills > muscle, and females consistently showed higher concentrations than males.

4.2. Estimated Daily Intake (EDI) and Target Hazard Quotient (THQ)

Tables 3 and 4 summarise the Estimated Daily Intake (EDI) and Target Hazard Quotients (THQ) of Ni, Pb, and Cd from consumption of *C. sapidus* tissues. At Station A, EDI values for Ni ranged from 2.14–4.73 µg/day in males and 3.47–6.41 µg/day in females. Corresponding THQ values exceeded 1.0 in all tissues, suggesting potential non-carcinogenic health risks. Lead EDIs ranged from 0.07–0.61 µg/day (males) and 0.13–0.81 µg/day (females), with THQs also above 1.0. Cd EDI values were lowest but still yielded THQ values ranging from 0.37 to 8.70, especially elevated in the hepatopancreas and gills of female crabs. At Station B, a similar trend was observed. EDI and THQ values for all three metals were generally lower than those from Station A but still exceeded safe thresholds, especially for females. Ni THQ values ranged from 4.44–14.44, Pb from 0.56–10.15, and Cd from 0.12–6.69. Overall, THQ values >1.0 across most tissues and metals indicate a significant risk of chronic health effects upon regular consumption of contaminated crab tissues, particularly from Station A.

Table 1. Concentration of heavy metals (mg/kg) in tissues of callinectes sapidus from station A

Metal	Sex	Tissue	Range	Mean ± SD
Ni	Male	Gills	138.72–139.65	139.25 ± 0.48
		Hepatopancreas	230.97–231.17	231.06 ± 0.10
		Muscles	103.86–105.02	104.23 ± 0.63

	Female	Gills	210.00–213.51	211.18 ± 2.02
		Hepatopancreas	311.67–313.53	312.59 ± 0.93
		Muscles	168.32–170.01	169.40 ± 0.94
Pb	Male	Gills	13.46–14.94	14.38 ± 0.80
		Hepatopancreas	29.72–29.76	29.74 ± 0.02
		Muscles	3.51–3.60	3.57 ± 0.05
	Female	Gills	21.17–21.35	21.24 ± 0.10
		Hepatopancreas	38.99–39.63	39.32 ± 0.33
		Muscles	6.29–6.32	6.30 ± 0.01
Cd	Male	Gills	0.45–1.50	0.82 ± 0.59
		Hepatopancreas	3.98–4.10	4.04 ± 0.06
		Muscles	0.26–0.35	0.30 ± 0.05
	Female	Gills	4.43–4.95	4.78 ± 0.31
		Hepatopancreas	8.91–9.03	8.99 ± 0.07
		Muscles	2.81–2.84	2.82 ± 0.02

Table 2. Concentration of Heavy Metals (mg/kg) in Tissues of Callinectes sapidus from Station B

Metal	Sex	Tissue	Range	Mean ± SD
Ni	Male	Gills	129.93–130.52	130.16 ± 0.32
		Hepatopancreas	182.97–183.65	183.40 ± 0.38
		Muscles	93.09–93.33	93.18 ± 0.13
	Female	Gills	192.06–192.14	192.12 ± 0.06
		Hepatopancreas	272.61–272.85	272.74 ± 0.12
		Muscles	165.63–165.84	165.71 ± 0.11
Pb	Male	Gills	10.07–10.25	10.12 ± 0.12
		Hepatopancreas	22.86–23.15	22.99 ± 0.15
		Muscles	2.73–3.02	2.91 ± 0.16
	Female	Gills	12.74–12.80	12.77 ± 0.03
		Hepatopancreas	37.01–37.08	37.04 ± 0.04
		Muscles	4.77–4.82	4.80 ± 0.02
Cd	Male	Gills	0.12–0.18	0.16 ± 0.03
		Hepatopancreas	2.04–2.10	2.07 ± 0.03
		Muscles	0.105–0.15	0.13 ± 0.02
	Female	Gills	3.59–3.66	3.63 ± 0.04
		Hepatopancreas	6.83–7.08	6.97 ± 0.13
		Muscles	1.47–1.56	1.52 ± 0.04

Table 3. Estimated Daily Intake (EDI) and Target Hazard Quotient (THQ) of Heavy Metals at Station A

Metal	Sex	Tissue	EDI (µg/day)	THQ
Ni	Male	Gills	2.85	6.67
		Hepatopancreas	4.73	11.11
		Muscles	2.14	5.00
	Female	Gills	4.33	10.19
		Hepatopancreas	6.41	15.00
		Muscles	3.47	8.15
Pb	Male	Gills	0.29	3.89
		Hepatopancreas	0.61	8.15
		Muscles	0.07	0.98
	Female	Gills	0.44	5.83
		Hepatopancreas	0.81	10.74
		Muscles	0.13	1.67
Cd	Male	Gills	0.02	0.74
		Hepatopancreas	0.083	3.89
		Muscles	0.01	0.37
	Female	Gills	0.12	4.26
		Hepatopancreas	0.184	8.70
		Muscles	0.15	3.70

Table 4. Estimated Daily Intake (EDI) and Target Hazard Quotient (THQ) of Heavy Metals at Station B

Metal	Sex	Tissue	EDI (µg/day)	THQ
Ni	Male	Gills	2.67	6.30
		Hepatopancreas	3.76	8.89
		Muscles	1.91	4.44
	Female	Gills	3.94	9.26
		Hepatopancreas	5.59	14.44
		Muscles	3.40	8.33
Pb	Male	Gills	0.21	2.78
		Hepatopancreas	0.47	6.30
		Muscles	0.06	0.56
	Female	Gills	0.26	3.50
		Hepatopancreas	0.76	10.15
		Muscles	0.10	1.34
Cd	Male	Gills	0.0034	0.16
		Hepatopancreas	0.04	1.99
		Muscles	0.0025	0.12
	Female	Gills	0.007	3.48
		Hepatopancreas	0.18	6.69
		Muscles	0.031	1.44

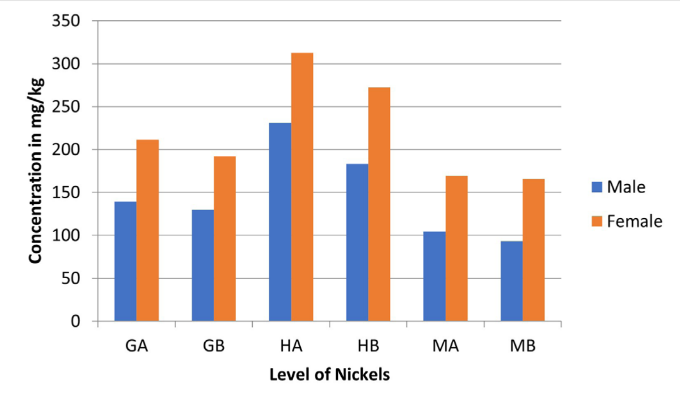

Figure 3. Comparison of Nickel Concentration in the Organs of the Male and Female *C. Sapidus* at Stations A and B

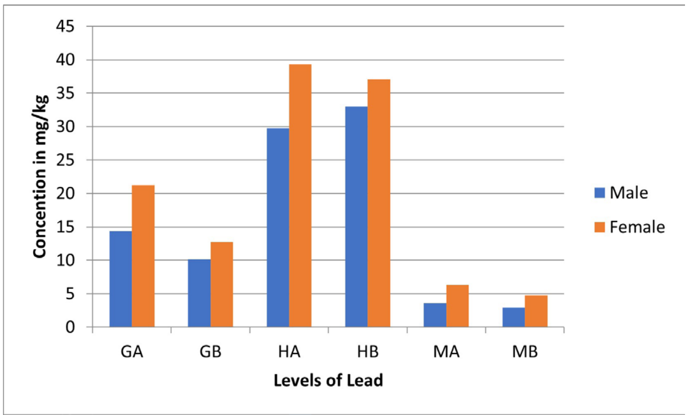

Figure 4. Comparison of Lead Concentration in the Organs of Male and *C. Sapidus* at Station A and B.

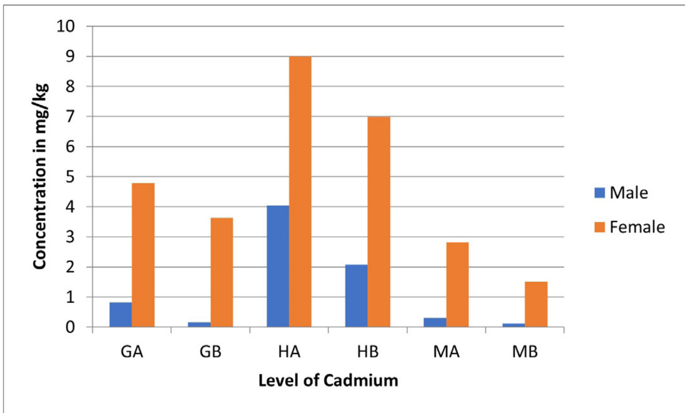

Figure 5. Comparison of Cadmium Concentration in the Organs of the Male and Female *C. Sapidus* at Stations A and B.

4.3. Discussion

The findings of this study revealed substantial concentrations of Nickel (Ni), Lead (Pb), and Cadmium (Cd) in the tissues of Callinectes sapidus collected from the Iko River, with variation across tissues, sexes, and sampling stations. These concentrations, in many instances, exceeded the regulatory limits set by global agencies such as the FAO/WHO and USEPA, underscoring the serious environmental implications and potential health risks for local consumers. The results revealed that the concentration of Ni, Pb, and Cd exceeded the various USEPA and FAO/WHO permissible limits. The result demonstrated that metal concentration in the different organs followed the hierarchical pattern H>G>M. Heavy metal accumulation in shrimp organs depends on the physiological role of the organ. Some tissues, such as the hepatopancreas, are considered target organs for metal accumulation. The hepatopancreas acts as a major site of metal uptake, storage, and detoxification, largely due to its role in synthesising low-molecular-weight, metal-binding proteins such as metallothioneins, which have a high affinity for heavy metals (Tsafe *et al.*, 2012; Sanyaolu *et al.*, 2022). Previous research has demonstrated that the hepatopancreas can accumulate heavy metals at concentrations significantly higher than those found in muscle tissue—sometimes up to 30-fold—owing to its high metabolic activity and detoxification functions.

The gills, being in direct contact with the ambient water, serve as critical interfaces for ion exchange and gas regulation. This constant exposure makes them particularly susceptible to environmental contaminants. Metals present in water can be absorbed directly across the gill epithelium, contributing to the relatively high levels of Ni, Pb, and Cd observed in this study. Their osmoregulatory function also facilitates the transportation and exchange of ionic substances, including metals, which explains the intermediate levels recorded in this tissue. The comparatively low concentrations observed in muscle tissues are consistent with previous studies that attribute it to lower metabolic activity and the limited presence of metallothioneins (Ubong *et al.*, 2023).

Sex-based differences were also pronounced, with female crabs consistently recording higher metal concentrations across all tissues. This variation may be attributed to physiological differences linked to reproductive cycles. During oogenesis, females require substantial nutrients and energy, which may result in the mobilisation and retention of higher metal loads, particularly in tissues like the hepatopancreas. Larger body size, lipid content, and hormonal fluctuations may also contribute to higher bioaccumulation potentials in females compared to males, as similarly reported in other ecotoxicological studies involving crustaceans and molluscs.

Notably, spatial differences in metal concentration between the two stations were significant. Crabs collected from Station A exhibited consistently higher levels of all three metals when compared to those from Station B. This discrepancy strongly suggests site-specific contamination, likely due to localised anthropogenic inputs. Station A is proximate and was more polluted because s close to the Utapete operational zone, which was reported for oil spills and gas flaring (Etesin *et al.*., 2013). These activities are known to release trace metals directly into aquatic systems, either through liquid waste or atmospheric deposition, thus increasing bioavailability and uptake by aquatic fauna. This supports the hypothesis that Station A is more impacted by industrial pollution than Station B.

The health risk assessment component of this study—evaluated through the Estimated Daily Intake (EDI) and Target Hazard Quotient (THQ)—showed that consumers who regularly ingest crab tissues, particularly the hepatopancreas and gills, are at potential risk of chronic toxicity. THQ values for Ni, Pb, and Cd were notably greater than 1.0 across several tissues, especially in female samples and at Station A, indicating a potential for non-carcinogenic health effects. Long-term exposure to these metals, even in trace amounts, has been associated with renal dysfunction, cardiovascular disorders, neurological impairment, and carcinogenesis (Bo *et al*., 2016). Lead and cadmium, in particular, are classified among the most toxic environmental pollutants with documented risks including kidney damage, reproductive toxicity, and developmental disorders. The ecological ramifications of these findings are also profound (FAO/WHO, 2011). Persistent contamination of aquatic ecosystems with heavy metals can impair the reproductive capacity, growth, and survival of various aquatic species. Moreover, bioaccumulation in edible aquatic organisms like *C. sapidus* raises concerns of biomagnification in higher trophic levels, thereby disrupting aquatic food webs. From a socio-economic perspective, this pollution threatens local fisheries, reduces biodiversity, and endangers the livelihoods of fishing communities in Eastern Obolo and surrounding regions.

5. CONCLUSION

The accumulation of heavy metals of Ni, Pb and Cd in *C. sapidus* blue crabs is to a considerable extent and relatively more than that reported from other regions in the literature. The high bioaccumulation of these metals is believed to be occurring due to the rigorous anthropogenic input of bio-accumulative contaminants into the aquatic environment. Though THQ calculations showed that THQ in all the *C. sapidus* were greater than 1, the Estimated Metal Intake, Health Risk Index, indicated a risk of developing cancer over time due to the carcinogenic ingestion. Therefore, blue crab from the creeks under study is considered unsafe for consumption. The study, therefore, recommended that a scientific method of detoxification is essential to improve the health of blue crabs. The need to continuously monitor the bioaccumulation of heavy metals and the activities of multinationals should be checked to discourage the endangerment of the flora and fauna.

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