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DETERMINATION OF HEAVY METALS IN CRAYFISH SOLD IN SELECTED TOWNS (Asaba, Ozoro, Patani and Sapele), DELTA STATE NIGERIA

Igbuku, A.U.
Department of Science Laboratory Technology
Delta State Polytechnic, Ozoro.
Email; Igbukuaugustinaufuoma@gmail.com

Abstract: Anthropogenic inputs of pollutants such as heavy metals into the marine environment have increased their levels to large extents within the past few decades. This study investigated the level of heavy metals in crayfish sold in selected towns (Asaba, Ozoro, Patani and Sapele) Delta State Nigeria. Crayfish samples were purchased from the local markets and digested using nitric acid/hydrochloric acid mixture. Heavy metal concentration was determined using Atomic Absorption Spectrophotometer (Buck 200). The result obtained ranged from 0.161 - 4.466mg/kg for Fe; 2.666 - 5.050mg/kg for Co; 0.074 - 0.517mg/kg for Cr; 0.235 - 0.758mg/kg for Mn and 0.513 - 4.875. Chromium was the most dominant metal while cadmium was the least occurring metal. The mean concentration of the metals follows in the order: Cr>Zn>Pb>Fe>Cu>Mn>Ni>Cd. The result revealed that Cr, Ni, Co and Pb exceeded the guideline safe limits by WHO/IAEA. The level of Cr, Ni, Co and Pb in this study calls for concern considering the toxic nature of the metals. There is thus the need to regularly monitor the prevalence of heavy metals in crayfish sold in the region.

INTRODUCTION

Heavy metals refer to any metallic chemical element with relatively high density and its specific gravity that is at least 5 times that of water (Lars, 2003). Aquatic ecosystems are continuously receiving high levels of heavy metals, with anthropogenic sources as the major source of heavy metals pollutants in aquatic system (Linnikand and Zubenko 2000). Sediments are important sinks for various pollutants such as pesticides and herbicides, while heavy metals in surface water may exist as simple hydrated ions as well as inorganic and organic complexes (Linnila, 2000). Heavy metals toxicity can result in lower energy levels and damage blood composition, lungs, liver, kidneys and other vital organs, damaged or reduced mental and central nervous functions even cause cancer. (Canly and Atty 2003, Tuzen 2003). Heavy metals are non-bio degradable and capable of accumulating in the body of plants and animals through food chain so that when man eats these organisms, they also deposit in the muscles of man resulting in various diseases depending on the metal involved (Abdu and Muazu, 2007). Living organisms require varying amounts of heavy metals. Iron, cobalt, tin aluminum, cupper, manganese, molybdenum and zinc are required by humans. Excessive level could be damaging to the organism. Other heavy metals such as mercury, plutonium, Sn and lead are toxic metals that have no known vital or beneficial effect on organisms, and their accumulation over time in the bodies of animals can cause serious illness while certain elements that are normally toxic are, for certain organisms or under certain conditions, beneficial include vanadium, tungsten and cadmium (Damisa *et al.*, 2006). Crayfish, the largest and the most valuable invertebrate of all inland waters, feed on detritus zoobentric animals and aquatic plants. Being omnivores, freshwater crayfish play an important role in the tropic chain of bentline communities in al inland waters. (lakes, rivers etc) and contribute in regulation of freshwater ecosystem. Freshwater crayfish species such as Astacus, Orconectes and cambarus are considered as biological indicators of clean waters because of their relatively lower locomotory activity in comparison with fresh water fish. (Eisler, 1981). Heavy metals are natural constituents of freshwater environment. Human activity has inevitably increased the levels of metal ions in many of these natural water systems, mine drainage, river oil and gas exploration, industrial (pesticides, paints, weather, textile, fertilizers and pharmaceuticals) and domestic effluents, agricultural run -off and rain etc have all contributed to the increased metal load on the these waters being ultimately incorporated into aquatic sediments. Sediments composed of fine sand and silt will generally have higher levels of absorbed metal than quartz, Feldspar and detritus carbonate-rich sediment (Eisler. 1981; Eisler. 1984). Any aquatic invertebrate will take up trace metals into the body from solution through permeable body surfaces and from the gut. Recently it has become increasingly appreciated that uptake of trace metals from the diet may be the major source of metals for many aquatic invertebrates, including barnacles (Wang, 2002). Metals passively absorbed onto the exoskeleton of a crustacean (with the potential to be desorbed when dissolved conditions change) will contribute to the total body concentration of metal in the crustacean, but its proportional contribution is usually small (Rainbow and White, 1989). The concentrations at which metals may be considered important vary as some are essential at low levels yet toxic at others. The objective of this present study was to determine the occurrence and levels of some heavy metals (copper, lead, cadmium, nickel, iron, manganese, chromium, cobalt and zinc) in crayfish commonly sold in Delta state, Nigeria.

SAMPLE AND SAMPLE COLLECTION

The crayfish samples were purchased from four selected towns in Delta State, Nigeria. The towns selected for this study are Asaba, Ozoro, Patani and Sapele.

SAMPLE PREPARATION AND DIGESTION

The crayfish samples were thoroughly grinded into fine particles. 2 g was weighed into a beaker and 3ml of nitric acid and 9ml of hydrochloric acid was added. The mixture was heated strongly in a hot plate until a clear solution was formed signifying the end of the digestion. The mixture was removed from the hot plate and allowed to cool to room temperature. The digested samples was filtered into 100ml volumetric flask using Whatman No.1 filter paper and made up to mark with 0.25M solution of nitric acid. All glass wares were washed with soap and rinsed with distilled water and then dried before used.

HEAVY METAL ANALYSIS

The metal analysis was done using atomic absorption spectrophotometer (Buck 200 A).

RESULT

The analytical results of some heavy metals analyzed in crayfish from four different towns in Delta State are presented in table 1 and figure 1 below.

Table 1: Showing the mean concentration levels of each metal in various samples of crayfish from four different places in mg/kg.

Heavy metal	Patani	Ozoro	Sapele	Asaba	MEAN ± SD
Fe	0.749	0.746	4.466	0.161	I.5305 ± 1.712
Cd	0.512	ND	ND	ND	0.128 ± 0.192
Cr	2.666	3.24	3.281	5.05	3.5593 ± 0.894
Co	0.074	0.268	0.278	0.517	0.2843 ± 0.157
Mn	0.235	0.263	0.316	0.758	0.393 ± 0.213
Zn	4.875	0.513	1.546	2.515	3.3623 ± 1.899
Cu	0.012	ND	ND	4.612	1.156 ± 1.820
Ni	ND	ND	0.62	0.226	0.2115 ± 0.2044
Pb	0.95	1.79	1.68	3.68	2.025 ± 1.0086

Table 2. Tolerance level for the Heavy metals in mg/kg

Heavy metal	WHO limit (mg/kg)	IAEA-407 (mg/kg) Wyse et al., 2003
Fe	40	146
Cd	0.5	0.19
Cr	0.05	0.73
Co	-	0.05
Mn	0.5	3.52
Zn	60.0	67.10
Cu	30.0	3.28
Ni	-	0.60
Pb	2.0	0.12

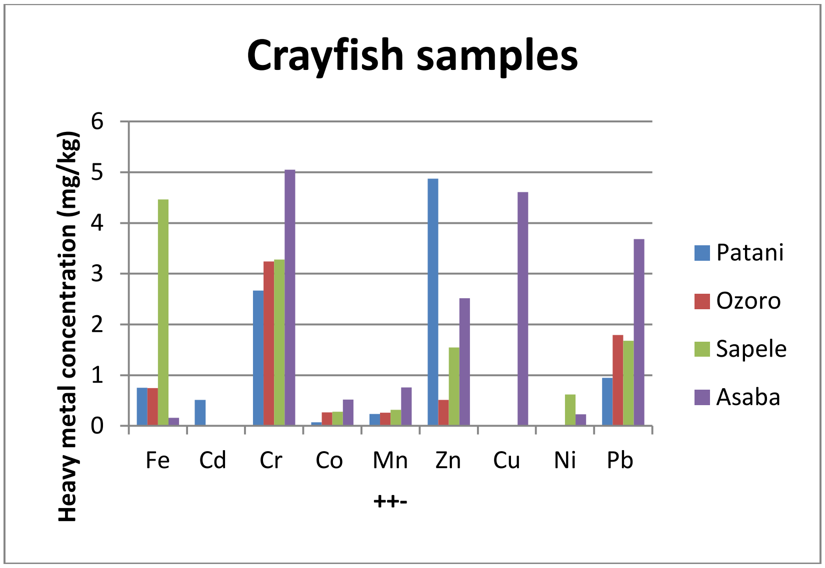

Figure 1: Barchart showing the distribution of Fe, Cd, Cr, Co, Mn, Zn, Cu, Ni, and Pb **in Crayfish samples in Asaba, Ozoro, Patani, and Sapele.**

DISCUSSION

The mean values of the heavy metals (Fe, Cd, Cr, Co, Mn, Zn, Cu, Ni, and Pb) in Crayfish from four (4) different locations (Asaba, Ozoro, Patani and sapele) in Delta State, Nigeria are given in Table 1 and Figure 1 above. The mean concentration of the studied crayfish samples follows in the order: Cr>Zn>Pb>Fe>Cu>Mn>Ni>Cd.

Iron concentrations in this study ranged from 0.749 to 0.161 mg/kg. Iron (Fe) concentration varied significantly from Sapele to Asaba. The highest concentration (4.466 mg/kg) of Iron was observed at Sapele while the lowest concentration (0.161 mg/kg) of Iron was observed at Asaba. The mean concentration of Iron (1.5305 mg/kg) did not exceed the WHO permissible limit (40 mg/kg) and IAEA limit of 146mg/kg. Iron is an essential part of hemoglobin responsible for oxygen transportation in the body (Igwemmar et al. 2013).

Chromium concentration ranged from 2.666 mg/kg to 5.05 mg/kg. Chromium concentration varied significantly from Asaba to Patani. The highest concentration (5.05 mg/kg) was observed at Asaba while the lowest concentration (2.666 mg/kg) was observed at Patani. The mean concentration of chromium (3.5593 mg/kg) exceeded the WHO limit of 0.05 mg/kg for food and IAEA value of 0.73mg/kg. Chromium is an important element enzyme cofactor which is toxic when accumulated in the liver and spleen (Wagner and Boman, 2003).

Zinc concentration ranged from 0.513 mg/kg to 4.875 mg/kg. The highest concentration (4.875 mg/kg) was observed at Patani while the lowest concentration (0.513 mg/kg) was observed at Ozoro. The mean concentration (3.3623 mg/kg) of zinc did not exceed the permissible limit of 60mg/kg for food and IAEA limit of 67.10mg/kg. Zinc is an essential trace element required in human metabolism and plays an important role in the function of many biochemical processes (Kupeli et al., 2014). Excessive zinc intake may lead to side effects ((Scherz and Kirchoff, 2006)

Lead concentration ranged from 0.95 mg/kg to 3.68 mg/kg. Lead concentration varied significantly from Patani to Asaba. The highest concentration (3.68 mg/kg) was observed at Asaba while the lowest concentration (0.95 mg/kg) was observed at Patani. The mean concentration of lead (2.025 mg/kg) exceeded the WHO permissible limit (2.00 mg/kg) but below IAEA limit of 0.12mg/kg. Lead is one of the most dangerous metals in human health and affects the central nervous system, causes anemia and gastrointestinal damage (Kelle et al., 2015).

Manganese concentration ranged from 0.235 mg/kg to 0.758 mg/kg. Manganese concentration varied significantly from Patani to Asaba. The highest concentration was observed at Asaba while the lowest concentration was observed at Patani. The mean concentration of manganese (0.393 mg/kg) did not exceed the WHO permissible limit (0.5 mg/kg) in food and IAEA limit of 3.52mg/kg..

Cobalt concentration ranged from 0.074 mg/kg to 0.517 mg/kg. Cobalt concentration varied significantly from Patani to Asaba. The highest concentration was observed at Asaba while the lowest concentration was observed at Patani. The mean concentration of cobalt (0.2843 mg/kg) exceeded the permissible limit of 0.05 mg/kg set by IAEA. Cobalt is an essential element required for many enzymatic systems and the formation of noble molecules like Vitamin B_{12} (Haluk et al., 2012).

Nickel concentration ranged from 0.226 mg/kg to 0.62mg/kg. Ni concentration varied significantly from sapele to Asaba. The highest concentration was observed at Asaba while the lowest concentration was observed at Sapele. Nickel was not detected in Patani and Ozoro samples. The mean concentration of Nickel (0.2115) exceeded the permissible level of 0.2mg/kg set by WHO and below the IAEA set limit. Nickel is an essential trace metal needed for normal growth and reproduction in animals and humans but may cargenogenic when consumed in higher amount (Malik, 2010).

Copper concentration ranged from 0.012mg/kg to 4.612mg/kg. The highest concentration was observed at Asaba while the lowest concentration was observed at Patani. Copper was not detected in Ozoro and Sapele sample. The mean concentration of Copper (1.156mg/kg) did not exceed the WHO permissible limit (30mg/kg) and IAEA limit of 3.52mg/kg. Copper is an essential element which enhances the enzymatic activity of the body (Igwemmar et al., 2013).

Cadmium concentration was detected only in Patani sample with (0.512mg/kg). The mean concentration of Cadmium (0.128mg.kg) did not exceed the WHO permissible limit (0.5mg/kg) and was slightly above IAEA limit of 0.19mg/kg. Cadmium has been associated with respiratory problems including lung cancer and gastrointestinal problems (Sorahan and Esmen, 2004; Drebler et al., 2002; Dai et al et al 20099).

CONCLUSION

The result obtained from the analysis indicates that Patani and Asaba samples contain high concentration of eight heavy metals. While Ozoro and Sapele sample contains less concentration of the heavy metals. It was also observed that cadmium, copper and Nickel were less detected in those samples. Bioaccumulation of these heavy metals over time can have serious consequence to human health, as such there should be need to improve quality control in the processing of these crayfish in order to reduce the metal concentration to a minimal levels.

RECOMMENDATION

Heavy metals accumulation in the environment could be very toxic even at an extremely low concentration. The ingestion of food is are obvious means of exposure to these metals not only because many of these metals are natural components of food stuffs, but also because of environmental contamination and contamination during processing. It will be of great advantage to the producers and the general public if there is adequate or improved quality control and regular inspection by the regulatory body before these crayfish are dispatch into the market.

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