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Heavy Metals Concentration In Industrial And Locally Processed Fish And Their Implication For Human Health

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ABSTRACT

Since the adverse effects of heavy metals concentration in human body is of global concern, this study was carried out to determine the concentration level of some heavy metals in processed food. In this research, processed fish species were worked on. Three industrially processed fish (canned fish), mainly sardines (*Sardinella aurita*); and three locally processed fish (smoked fish) consisting of catfish (*Siluriformes*), scumbia (*Scomber scombrus*) and tilapia ((*Oreochromis niloticus*). These are fish species that are commonly consumed, especially in Niger Delta area and most parts of the country. They were used in this research to ascertain the safety level of processed fish species. Of particular concern were those stored in lacquered metal containers. Seven heavy metals, namely cadmium (Cd), lead (Pb), chromium (Cr), manganese (Mn), copper (Cu), iron (Fe) and zinc (Zn) were determined to ascertain their health risk level. Using wet digestion method, the samples were digested using analytical grade chemicals. Heavy metals concentrations were determined with the aid of atomic absorption spectrometric technique. From the analyses, the following results were obtained for the digested dry samples: Cd: 0.012 - 0.020 µg/g, Cr: 0.001 - 0.063 µg/g, Cu: 0.066 – 0.223 µg/g, Mn: 0.727 – 2.745 µg/g, Pb: 0.126- 0.388 µg/g, Fe: 32.76 – 38.44 µg/g and Zn: 0.863 – 1.193 µg/g. The result shows high values for abundance of iron, manganese, lead and zinc concentration in the samples, while the concentration of other heavy metals analysed were in less quantities. The order of heavy metals in the fish samples is Fe > Mn > Zn > Pb > Cu > Cr > Cd. It was also observed that the locally processed samples had higher contents of iron, manganese, zinc and lead. However, values obtained were within WHO recommended standard. From this analyses it can be deduced that locally produced fish species would require regulation on how and process needed to reduce these heavy metals in the products. In addition, even though the values for cadmium, copper and lead were lower, but there is the need to watch them so as to prevent bioaccumulation in humans, which can result in medical tragedy. This shows the need to control these metals so as to prevent future catastrophes.

Keywords: Fish, Heavy metals, Toxicological effects, Health risk

INTRODUCTION

In the world of today we are faced with unimaginable developments on daily bases. This in most cases results in sustainability and improved brands. It also eventually results in contamination of the environment by heavy metals, inorganic, organic, and organometallic components. There has been a growing interest in monitoring of heavy metals in various organisms. Heavy metals are generally released into aquatic environments in different forms and accumulation of these metals is dependent on the concentration of the metal and the exposure period. There have been many reports on contamination of fish

by chemicals in the environment. Heavy metals are considered the most important constituents of pollution from aquatic environment and sea because of their toxicity and accumulation by marine organisms, such as fish. Fish can accumulate substantial amounts of metals in their tissues especially muscles and this can represent a major dietary source of these metals for humans. High levels of heavy metals in fish, sea foods and fish products have been widely reported (Türkmen et al., 2008).

Low or high trace element's imbalances can be considered as risk factors for several diseases. Metals, such as zinc (Zn), copper (Cu) and iron (Fe) are essential metals since they play important roles in biological systems. Iron is a vital component for human life and the human body contains 60-70 µg/g of iron. Most importantly, the iron compounds, specially hemoglobin and myoglobin are essential for human survival since they are responsible for transporting various items in the body (Abbaspour et al., 2014).

Fish is a major source of iron for humans. Iron deficiency causes anemia. Cu is known to be essential and may enter foodstuff during its processing or by environmental contamination. Cu is an essential constituent of metalloenzymes and is required for hemoglobin synthesis and catalysis of metabolic reactions. However, Cu ions such as Cu_2OH^+ and $CuOH^+$ are toxic to the fish (Hosseini et al., 2015).

Fish and other aquatic animals are found in water that is constantly exposed to chemical effluents, pollutants and other contaminants. Fish may be contaminated by toxic elements during growth since they live in this environment or through transportation and storage. Contamination may also occur during production, handling and canning process. Fish have been found to be good indicators of heavy metals contamination in aquatic environment because they occupy different tropic levels and are of different sizes and ages. Food safety therefore has become a major public concern worldwide and has stimulated researches regarding the risk associated with consumption of contaminated sea foods (Haddad et al., 2015).

Canning, which is one of the methods of food preservation, involves processing and sealing the content in an air tight lacquered container thereby extending the content's shelf life. The aim is to make the food content readily available, palatable, eatable and safe for a long period. Canned food is frequently and largely consumed in Nigeria; and in recent years, there has been an inflow of different types of canned sea food, particularly fish, into the Nigerian market (Ojezele et al., 2021).

Heavy metals presence in canned or industrially processed fish and locally processed fish may be mainly through the source, such as t he water in which the fish was breed, the river source or in the processing which involve the use of heavy machines in the case of industrially processed and hygienically uncleansed or crude method in the case of locally processed. In canning toxicology, maintenance methods, treatment of what is to be canned and other additives added may create future contamination; including that of heavy metals (Bakircioglu et al., 2015).

In addition, method of food packaging have effects on food safety. The possibility of movement of chemicals from the contact materials into the food product cannot be ruled out. This necessitates the extensive study of the metal content of food since some metals are essential for homeostasis while some are remarkably toxic even at low quantity. It was observed that the interface of metal ions with nuclear proteins can also lead to carcinogenesis, programmed cell death or changes in DNA conformation (Ojezele et al., 2021).

MATERIALS AND METHODS

Sample Collection

Six different fish samples were procured for analyses. This consist of three canned fish and three locally processed fish. The analysed canned fish samples, sardines, were procured from Igbudu market in Warri, which is located within coordinates Latitude $5^O31'10"$ N and Longitude $5^O45'36"$ E; while the locally processed fish species, otherwise known as smoked fish were procured from the Warri main market by the waterside; having coordinate Latitude 5^O 3044" N and 5^O 4449" E. All the canned samples were sardines (*Sardinella aurita*); while the locally processed fish samples consist of catfish (*Siluriformes*), scumbia (*Scomber scombrus*) and tilapia ((*Oreochromis niloticus*).

Sample Preparation

The six samples were coded; and each kept in transparent polythene bags separately. They were then kept a refrigerator. All these were done strictly under quality control procedures, such as the use of protective

latex hand gloves so as to avoid contamination. Samples were prepared by initially mopping them with filter paper to remove oil, especially the canned samples which are soaked in cod liver oil. About 20gm of each sample was then dried in oven until the dry weight became constant. This was carried out at 90^{O}C for about 3 hours. These samples were then grinded into powdery form one after the other and digested by employing the USEPA Method 3050B (USEPA 1996; Radojevic & Bashkin, 1999) for the digestion of heavy metals. 1gm of each sample was weighed into a 100 cm^3 pyrex beaker, made wet with deionized water and to it was added 10cm^3 of 2% nitric acid. This was heated on a hot plate at 100^{O}C until the samples were completely dissolved or digested. The content was heated to almost dryness and to it was added 10cm^3 of 4M hydrochloric acid and was further heated to almost dryness and to ensure proper complete digestion. The sample was then filtered. The liquid filtrate was transferred into a 50.00cm^3 standard volumetric flask. The content was diluted with deionised water and made up to the 50.00cm^3 mark. This sample was sent to analytical laboratory for the analyses of the heavy metals; and was done with the aid of atomic absorption spectrophotometer.

RESULTS AND DISCUSSION

Table 1: International Standards for Heavy Metals in Processed Fish (µg/g)

Samples	Pb	Cr	Zn	Cd	Cu	Mn	Fe
			µg/g				
W.H.O Standard	0.2	0.5	100	0.1	30	0.3	100
USEPA Standard	0.5	5	100	5	30	10	100

Source: Baodi et al., 2011

Table 2: Values Obtained for Laboratory Analyses of Digested Samples (µg/g)

Samples	Cd	Cr	Cu	Fe	Mn	Pb	Zn
				(µg/g)			
IPFA	0.02	0.055	0.117	33.326	0.896	0.153	1.066
IPFB	0.012	0.057	0.223	32.764	0.727	0.285	1.156
IPFC	0.018	0.063	0.148	31.753	2.745	0.126	1.193
LPFA	0.017	0.004	0.095	37.336	2.152	0.129	0.863
LPFB	0.015	0.005	0.066	36.785	2.375	0.388	0.975
LPFC	0.015	0.001	0.104	38.445	2.427	0.279	0.735

The concentrations of heavy metals under study is as presented in Table 2. The results shows cadmium (Cd) concentration ranging from 0.012 – 0.02 µg/g; chromium (Cr) from 0.001 – 0.063 µg/g; copper (Cu) from 0.066 – 0.223 µg/g; manganese (Mn), from 0.727 – 2.745 µg/g; lead (Pb), from 0.126 – 0.388 µg/g; iron (Fe), from 32.76 – 38.44 µg/g and zinc (Zn) from 0.836 – 1.193 µg/g. From the outcome of the analyses, one can also deduce that Cd, Cr, Cu and Zn are prevalent in industrially processed or canned fish as compared to those that were done locally. On the other hand, Mn and Pb are of higher quantities in locally processed fish, otherwise known as smoked fish. Iron (Fe) contents are in mixed form. Result shows that Fe distribution cut across all the species. Generally the concentration of these heavy metals is in the order: Fe > Mn > Zn > Pb > Cu > Cr > Cd. Result also show that all the values obtained are within World Health Organisation/ Food and Agricultural Organisation (WHO/FAO) and USEPA limit or intervention values. These values are in agreement with the findings of Rajkowska and Protasowicki (2013), Chinma et al. (2017), Mohammed et al. (2019) and Jacquin et al. (2020).

Fish, being in the higher levels of the aquatic food chain, can accumulate heavy metals over time. This poses a potential health risk to consumers if these metals exceed permissible levels. Different fish species have varying susceptibilities to heavy metal accumulation. Predatory fish, such as tuna and swordfish, tend to accumulate higher levels due to their diet and longer lifespans. Processing methods like cooking, frying and canning can influence heavy metal concentrations in fish. While certain methods might reduce some metal levels, others may increase their bioavailability. Due to this, regulatory agencies, such as the Food and Drug Administration (FDA), National agency for Food and Drug Administration and Control NAFDAC) and other related agencies should keep close watch on these heavy metals since bioaccumulation of them can trigger disaster. Incessant consumption of fish having these heavy metals can lead to high levels of heavy metals resulting in various health problems such as neurological disorders, organ damage, developmental issues and even cancer. Governments and international organizations needs to regularly monitor heavy metal concentrations in processed fish to identify trends, assess risks, and enforce safety standards. Implementing sustainable fishing practices and reducing pollution sources can also help mitigate heavy metal contamination in fish.

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