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FULL LENGTH RESEARCH ARTICLE

SAFETY OF FISH FROM NIGERIAN COASTAL WATERS

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ABSTRACT

The safety of seafood (fish) from Nigerian coastal waters was studied using heavy metals as index of pollution using finfish samples from four locations (Badagry, Nun River, Sambreiro River, and Cross River). Pb, Cr, and Cd were found to be moderately elevated in 50%, 37.1%, and 35% of the samples respectively. In contrast, Mn, Zn, Cu, and Fe exhibited no discernable elevation. The distribution of heavy metals in finfish and safety status of the fish samples are discussed.

Keywords: Finfish, heavy metals, bioaccumulation, pollution, coastal water, seafood.

INTRODUCTION

There has been growing interest to determine heavy metal levels in the marine environment (Kalay *et al.,* 1999). Levels of contaminants in fish are of particular interest because of the potential risk to humans who consume them (Burger & Gochfeld, 2005). Fin and shell fishes have been widely used as bio-indicators to monitor heavy metals concentrations in the coastal environment, due to their wide range of distribution, and also their important position in the food chain.

The exploration and exploitation of oil is associated with flaring of gases, several operational and accidental spills, use of drilling chemicals, and burning of fuel that release heavy metals into coastal waters. Pollution studies have revealed elevated levels of Pb, Cr, Ni, V, and Zn in Port Harcourt and Warri sediments and some species of fauna, suggesting inputs from petroleum exploration and exploitation (Kakulu & Osibanjo, 1988; Kakulu & Osibanjo, 1992). Consequently, the concentration of these metals in Nigerian coastal waters and sediment are of great concern, warranting the need for periodic sampling and analyses of both water and water resources in order to monitor the pollution and productivity status of the marine ecosystem and compare the data with international standards (Ajao *et al.,* 1996; Nubi *et al.,* 2008).

This paper reports the results of a study aimed at evaluating the trace elements such as Cd, Pb, Mn, Zn, Cu, Fe and Cr in different species of finfish from coastal waters at Badagry, Nun River, Sombreiro River, and Cross River. The data accumulated herein are compared with previous work from similar environment, and also with WHO acceptable limits.

Materials and Methods

Fish samples were collected during an oceanographic cruise. The choice of sampling stations was influenced by closeness to industrial locations. The finfish samples were identified, washed and frozen at -18^{0}C as soon as possible to avoid loss of sample integrity. Two species were identified and reported for some of the finfish samples at the study locations. This is to give room for further studies on the relationship between heavy metal bioaccumulation and age or size of finfish species.

About 10 g of finfish fresh weight tissue sample was placed in a beaker and 15 ml of freshly prepared mixture of HNO_3 /H_2O_2 (1:1, v/v) was added. The beaker was covered with a wash glass and set aside for about 1 hr during which the initial reaction would have subsided. The beaker and its contents were placed on a hot plate, whose temperature was allowed to rise gradually, until it attained a maximum of 160 ^{o}C in a fume cupboard. Heating continued for about 2 hrs, reducing the volume in the beaker to about 2 – 5 ml. The beaker and its contents were allowed to cool and transferred with whatman filtration into a 25 ml volumetric flask and made up to mark with distilled water (FAO/SIDA, 2003).

Reagent blanks were prepared accordingly to test the purity of the reagents. Metal concentrations for all extracts were determined using Pye Unicam model 969 Atomic Absorption Spectrophotometer (air-acetylene flame). Deuterium background correction was used for Cd, Fe, Pb, and Zn, and blank corrections were applied for each set of analyses. Accuracy was assessed by analysing three replicates of selected samples yielding standard deviations lower than 10 % for Pb, 5 % for Cd, Zn, and Cr, <3 % for Fe, Cu, and Mn. To validate the analytical methods employed in sample preparation and analyses for this study, percentage recovery was calculated for each of the metals in a series of five (5) repeat analyses of fish sample. This was made by spiking the samples with a known concentration of a mixed standard of the metals. The acceptable recovery was set within 79% to 105 % of added amount. The mean recoveries and the standard deviations were as follows: Cr (98.2 $\pm$ 11.26), Pb (95.2 $\pm$ 7.12), Cd (93.2 $\pm$ 5.36), Mn (86.23 $\pm$ 2.34), Zn (87.20 $\pm$ 6.18), Cu (90.23 $\pm$ 2.0), Fe (96.12 $\pm$ 3.45). The final concentrations were not corrected based on recovery.

RESULTS

The total concentration of metals in finfish samples from the coastal waters of Nigeria is shown in Tables 1-4. The results showed a wide range of values from none detectable to high values considered too high compared with WHO acceptable standards. The analytical results for heavy metals for finfish samples from Cross River are presented in Table 1. For Cross River location, the concentration ranges in µg/g for Cu, Fe, Mn, Zn, Cd, and Pb were (nd – 9.14), (19.37 – 91.42), (nd – 7.41), (2.80 – 11.85), (1.24 – 4.04), and (nd – 9.50) respectively. Cr was not detected in any of the sample collected in this location. The mean values are shown in the Table 1.

TABLE 1. HEAVY METALS LEVELS IN µg/g RECORDED FOR CROSS RIVER LOCATION

Sample Name	Cu	Fe	Mn	Zn	Cd	Cr	Pb
Trichurus lepturus	N.D	23.19	N.D	4.99	2.04	N.D	9.50
Trichurus lepturus	6.69	91.42	6.83	8.04	4.04	N.D	4.15
Ilisha Africana	1.00	36.85	7.41	2.80	2.10	N.D	6.00
Ilisha Africana	5.12	49.49	7.00	10.74	2.21	N.D	7.01
Priacanthus arenatus	4.16	43.44	6.36	5.88	1.31	N.D	N.D
Priacanthus arenatus	3.80	19.37	3.63	7.50	1.51	N.D	5.45
Brachydeuterus auritus	4.20	27.48	1.10	4.43	1.24	N.D	1.75
Brachydeuterus auritus	9.14	80.38	4.79	11.85	2.50	N.D	2.35
Range	N.D-9.14	19.4-91.4	N.D-7.41	2.8-11.9	1.24-4.04	N.D	N.D-9.50
Mean	**4.80**	**46.45**	**5.30**	**7.03**	**1.85**	**N.D**	**5.17**

ND – None Detectable

The analytical results for heavy metals in µg/g for Badagry finfish samples are presented in Table 2. For Badagry location, the concentration of the metals is given in Table 2. The highest metal concentrations µg g^{-1} for Cu, Fe, Mn, and Pb are 27.71, 63.83, 3.76 and 2.85 respectively, and was observed in finfish *Zanobatus scheinleini*. The highest Cd level of 5.16 µg g^{-1} was observed in *Pseudotolithus senegalensis*, and Cr 37.01µg g^{-1} in *Pseudotolithus typus.*

The analytical results for heavy metals in fish samples from Nun River are presented in Table 3. For Nun River location, metal concentration is shown in Table 3. The highest concentrations for Mn, Zn, Cd and Pb of 2.02, 56.80, 3.46 and 5.85 respectively were observed in finfish *Serranus accraensis*. The highest Cu level of 3.32µg g^{-1} was observed in *Raja miraletus*, Fe, 13.0µg g^{-1} in *Monocanthidae* and Cr, 26.3µg g^{-1} in *Priacanitus arenatus.*

TABLE 2. HEAVY METALS LEVELS IN µg/g RECORDED FOR BADAGRY LOCATION

Sample Name	Cu	Fe	Mn	Zn	Cd	Cr	Pb
Zanobatus scheinleini	5.96	36.45	1.33	5.01	1.15	N.D	1.89
Zanobatus scheinleini	7.71	63.83	3.76	12.01	1.85	N.D	2.85
Cynoglossus brownie	1.27	1.98	N.D	28.86	1.91	N.D	N.D
Pteroscion larimus	0.35	2.84	N.D	23.32	1.77	N.D	N.D
Pteroscion larimus	1.04	2.50	N.D	24.68	0.04	N.D	N.D
Chlorosocombus chrysumus	1.08	26.45	N.D	44.08	4.86	N.D	N.D
Chlorosocombus chrysumus	1.57	8.24	N.D	34.50	2.21	N.D	0.34
Pentanemus quinquarius	2.10	8.20	N.D	33.09	1.19	N.D	N.D
Pentanemus quinquarius	1.77	9.86	N.D	22.29	4.40	4.17	N.D
Pseudotolitus senegalensis	2.87	12.64	1.13	24.97	5.16	N.D	1.69
Cynoglossus canariensis	N.D	28.03	0.64	25.33	3.60	26.30	1.05
Pseudotolithus typus	3.11	13.61	N.D	24.24	2.95	37.01	N.D
Range	N.D-7.71	1.9-63.8	N.D-3.76	5.0-44.1	0.04-5.16	N.D-37.0	N.D-2.85
Mean	**2.62**	**17.88**	**1.72**	**25.20**	**2.59**	**22.49**	**1.56**

ND – None Detectable

DISCUSSION

There was a very wide fluctuation in the concentrations of Cr in all the locations. In Cross River, Cr was not detected in any of the samples. Out of the 12 samples analysed in Badagry, Cr was detected in only 3 samples with a high mean value of 22.49 µg/g. A total of 9 out of 11 samples in Nun River contained Cr with a high mean value of 16.25 µg/g. In Sombreiro River, 7 out of 9 samples contained Cr The levels of the other metals in the fish samples were low when compared with the WHO accepted levels.

The results obtained in this study were not consistent with previous results in finfish from the Lagos lagoon. Okoye (1991) reported the level of Pb to be 2.28 µg/g fresh weight and only in the concentration of Zn that he recorded a value of 27.50 µg/g, close to the value obtained in Badagry and Nun Rivers, and higher than the values obtained from both Sombreiro and Cross Rivers.

In general, about 50 % of all the 40 finfish samples from the coastal waters of Nigeria have a high concentration of Lead exceeding the WHO acceptable level of 2.0 µg/g. About 34% of all the samples had Cd concentration exceeding the WHO acceptable level of 2.0 µg/g. This is a serious concern for the safety of seafood in Nigerian coastal waters.

It is very obvious from the data presented here that the tolerable limits set by WHO were exceeded in 50% of the fin fish sample analyzed. The incremental addition of Pb to sea foods, from urban dust and aerosols (from automobile exhausts and fossil fuel use) is likely responsible for this high levels. Earlier studies in the Nigerian coastal waters reported 6.40 µg/g as maximum level for Pb in finfish from Warri area of Niger Delta (Kakulu *et al*., 1992).

The metal Cr is carcinogenic to man and other mammals. The widespread use of this metal in the leather and textile industries provides sufficient motivation for the continued monitoring of local seafood for this metal.

TABLE 3. HEAVY METALS LEVELS IN µg/g RECORDED FOR NUN RIVER LOCATION

Sample name	Cu	Fe	Mn	Zn	Cd	Cr	Pb
Platycephalus gruveli	3.17	2.45	N.D	29.55	1.03	22.06	N.D
Priacanithus arenatus	2.18	1.68	1.07	38.67	2.54	26.29	3.25
Pseupeneus prayensis	1.72	1.63	N.D	38.41	0.38	14.64	N.D
Dactycyphalus volitans	N.D	2.75	N.D	38.41	1.89	23.06	N.D
Prianthus arenatus	2.78	3.86	N.D	48.39	1.68	10.72	N.D
Balistes vetusa	3.11	3.55	N.D	46.34	2.07	11.71	N.D
Balistes vetusa	2.66	8.45	N.D	34.45	1.03	N.D	N.D
Serranus accraensis	2.45	9.75	2.02	56.78	3.46	N.D	5.85
Serranus accraensis	3.03	6.80	N.D	39.10	2.10	7.97	N.D
Raja miraletus	3.32	7.45	0.18	34.10	2.13	11.31	0.70
Monocanthidae	2.50	12.98	0.94	4.16	0.26	18.53	2.90
Range	N.D-3.32	1.6-13.0	N.D-2.02	4.6-56.8	0.26-3.46	N.D-26.3	N.D-5.85
Mean	2.69	5.58	1.05	37.12	1.71	16.25	3.17

ND – None Detectable

TABLE 4. HEAVY METALS LEVELS IN µg/g RECORDED FOR SOMBREIRO RIVER LOCATION

Sample Name	Cu	Fe	Mn	Zn	Cd	Cr	Pb
Pomadaesys jubelini	2.75	16.92	0.69	8.85	0.34	0.20	2.10
Pomadaesys jubelini	3.49	9.88	1.21	18.41	1.33	N.D	3.80
Chroroscombrus chrysurus	N.D	14.80	1.04	3.01	0.79	N.D	3.55
Chroroscombrus chrysurus	1.76	10.72	1.09	3.12	059	13.86	3.60
Dasyatis margarita	5.54	15.09	1.48	4.26	0.04	57.83	3.70
Ilishsa Africana	N.D	10.09	0.96	2.07	0.38	3.83	4.35
Brachydeuterus auritus	4.04	3.78	1.42	0.92	0.68	14.43	5.40
Geleiodes decadactylus	2.14	11.21	0.97	2.26	0.84	11.54	4.45
Caranx senegalensis	2.71	19.42	1.56	1.50	1.36	36.55	4.30
Range	N.D-5.5	3.8-19.4	0.69-1.56	0.9-18.4	0.04-1.4	N.D-57.8	2.10.5.40
Mean	3.20	12.43	1.15	4.93	0.71	17.89	3.91

ND – None Detectable

The long half–life of Fe in humans gives rise to its accumulation in vital organs such as the liver. The elevated concentration of Pb in finfish from the coastal rivers in Nigeria is a source of concern. Continuous monitoring should be carried out to safeguard public health The same view holds for Cd and Cr. For the other metals Zinc, Cu, Fe, their concentrations are within acceptable limit and not considered to pose problems.

Increased risks to human health resulting from microbial, radiological, and chemical contamination of coastal waters remain a major concern. It is often doubtful that inorganic chemical such as the transition metals are the most serious marine contaminants from public health perspective. The inspection of seafood for human consumption is often not sufficiently rigorous. However, there is a clear linkage between the risk posed to human health by chemical contaminants and land based activities from which they are predominantly derived. The contamination of near- shore waters from coastal urban communities and industrial development has sufficient impacts on local coastal fisheries. Fortunately, it is possible to provide basic human health protection through appropriate monitoring programmes.

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