Health Risk of Consuming Dried Crayfish Sold in the Bayelsa State Markets, Nigeria

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Abstract
Despite the wide range of benefits (source of vitamin B, copper, selenium, protein, iron, zinc, and amino acids) we get for eating crayfish, it could still be harmful to humans if there are certain levels of heavy metal contaminants in them when consumed. In this paper, heavy metals were determined (using flame atomic absorption spectrophotometer) in dried crayfish obtained in Markets in Bayelsa State, Nigeria. Prior to this instrumental analysis, dried samples were acid-digested via standard analytical methods. The health risks of consuming these samples were also assessed by using standard methods such as Estimated Daily Intake, Hazard Quotient, Hazard Index, Risk Index. For both children and adult (with some exception), metals may not pose any health risk because the Estimated Daily Intake for all elements were less than the Rfd values. Also, the Hazard Quotients and Hazard Indices do not indicate any health risk because they were less than 1. The RI values of Cr in all samples were significant for both children and adults and Pb in all samples were insignificant for both children and adults. Cd and Ni in samples A - D were not computed because there concentrations were below detection limit. The RI values of Cd were significant in all samples except in sample E. The RI values of Cr were significant in all samples except in samples E and G. With the exception of few samples, the health risk assessments show that crayfish samples are safe for consumption.

Keywords: *crayfish, Hazard, Quotient, Index*

INTRODUCTION

There is a worldwide use of crayfish as a constituent in the preparation of various meals and it is known for both its great taste and lot of vitamin minerals (Ahmad et al., 2013).
Categorized as seafood, studies have shown that cooked crayfish is rich in vitamin B, copper, selenium, protein, iron, zinc, and amino acids. And they help promote body metabolism as well as regenerating body cells. The omega-3 fatty acids contained in crayfish help to promote eyesight by reducing the risks of loss vision and macular degeneration (Shaban & Safwat, 2015).
Despite the wide range of benefits we get for eating crayfish, it could still be harmful to humans if there are certain levels of heavy metal contaminants in them when consumed. The crayfish can be contaminated with heavy metals when they are exposed to polluted environment (water, air, and land) (Balasubramanian *et al* 2009; Banfalvi, 2011). The health effects of ingesting heavy metals were reported in the literature (Akesson *et al*, 2008; Gladys, 2010; Kirmani *et al* 2011; James, 2011; Bolton *et al*, 2011).

Different levels of heavy metals in crayfish were reported by different researchers (Igbuku, 2015; (Al-Ubaidi, *et al*, 2014; Guner, 2010; Kurun *et al*, 2009; Adah *et al*, 2013; Qian *et al*, 2015; Waribo *et al* 2019). The aim of this study was to assess the health risk of consuming dried crayfish sold in markets in Bayelsa State.

MATERIALS AND METHODS

Materials

An Analyst 800 atomic absorption spectrometer from Perkin Elmer (Perkin Elmer, Norwalk, USA)
All reagents were of analytical reagent grade (E. Merck, Darmstadt, Germany)

METHOD: sampling/sample preparation

Crayfish samples, Solar thermo elemental Atomic Absorption Spectrophotometer (Flame AAS) mode: S4=71096.

Eight composite crayfish samples were made (labeled A, B, C, D, E, F, and G) from 24 saimples purchased from different markets in Bayelsa State, Nigeria. Samples were ground to fine powder. 1.0 g of each of the ground composte sample, 30 mL of 65 % HNO3 was added, and then the mixture was boiled gently over a hot plate (90 °C) for 1–2 h or until a clear solution was obtained. Later, 2.5 mL of 65 % HNO3 was added, followed by further heating until all the brown sample has turned white or colourless.

HEALTH RISK

The risk of consuming crayfish contaminated with heavy metals was assessed by computing the estimated daily intake (EDI), hazard quotient (HQ), hazard index (HI), and risk index (RI). These health risk parameters were calculated using equations 1, 2, 3, and 4 [14]:

$$EDI(mg/kg/day) = \frac{C_{metal} \times W_{fish}}{BW} \quad \ldots\ldots\ldots\ldots 1$$

$$HQ = \frac{EDI}{Rfd} \quad \ldots\ldots\ldots\ldots 2$$

$$HI = \sum_{i=1}^{n} HQ_i \quad \ldots\ldots\ldots\ldots 3$$

$$RI = EDI \times SF \quad \ldots\ldots\ldots\ldots 4$$

Where; EDI = estimated daily intake; C_{metal} = concentration of metal in mg/kg; W_{fish} = represents the daily mean ingestion of fish; BW = body weight; Rfd = reference dose values; HQ = hazard quotient; HI = hazard index; RI = risk index; SF = cancer slope factor. The standard values of parameters are given in Table 1 [14].

Table 1. Standard values of variables in equations

		Children	Adult		
Wcaryfish		0.027	0.041	kg/day	
BW		30	70	kg/day	
As	Zn	Fe	Ni	Pb	
0.003	0.3	0.36	0.2	0.004	Rfds (mg/kg/day)
1.5			0.91	0.0085	cancer slope factor
Cr	Cu	Cd	Hg	Mn	
0.003	0.04	0.001	0.0005	0.014	Rfds (mg/kg/day)
0.5		0.38			cancer slope factor

RESULTS AND DISCUSSION

The results of this investigation are given in Tables 2 – 6; the mean concentrations of the metals are given in Table 2 and the health risk indices are given in Tables 3 – 6. The Estimated Daily Intake (EDI), Hazard Quotient (HQ), Hazard Index (HI), and Risk Index (RI) are respectively given in Tables 3, 4, 5, and 6.

Table 2. Mean concentrations of heavy metals

	Concentration (mg/kg)						
sample	**Cr**	**Pb**	**Cd**	**Ni**	**Zn**	**Fe**	**Cu**
A	3.546 ±0.02	0.011 ± 0.02	BDL	BDL	1.119 ±	2.321 ± 0.01	1.002 ± 0.01
B	0.894 ± 0.01	0.009 ± 0.01	BDL	BDL	2.758 ± 0.01	0.961 ± 0.02	2.031 ± 0.20
C	2.666 ± 0.01	0.015 ± 0.01	BDL	BDL	0.533 ± 0.01	1.589 ± 0.02	0.192 ± 0.20
D	1.027 ± 0.02	0.004 ± 0.01	BDL	BDL	2.182 ± 0.20	4.523 ± 0.01	1.162 ± 0.01
E	2.587 ± 0.01	2.985 ± 0.20	0.05 ± 0.02	0.114 ± 0.02	2.547 ± 0.01	5.014 ± 0.01	2.214 ± 0.01
F	4.368 ±0.01	1.547 ± 0.02	0.65 ± 0.02	1.247 ± 0.01	4.854 ± 0.02	6.871 ± 0.01	3.247 ± 0.01
G	8.987 ±0.20	6.332 ± 0.02	1.987 ± 0.01	0.014 ± 0.20	3.417 ± 0.01	7.014 ± 0.02	4.014 ± 0.02
H	5.811 ±0.01	5.874 ± 0.01	2.214 ± 0.01	1.241 ± 0.20	1.24 ± 0.02	4.214 ± 0.20	2.987 ± 0.20
WHO permiss -ible limits	0.05	2	0.5	0.2	60	40	30

Cr levels in samples were above WHO permissible limits. The concentrations of Pb in samples A, B, C, D, and F were below WHO permissible limits while the concentrations were above the limits in samples E, G, and H. Cd levels were below detection limits in Samples A, B, C, and D; levels were below limits in Sample E; levels were above limits in Samples F, G, and H. The concentrations of Ni in Samples A, B, C, and D were below detection limits while levels of this metals were below WHO limits in Samples E and G. concentrations were above WHO limits in Samples F and G. The concentrations of Zn, Fe, and Cu were below WHO permissible limits in all samples.

Concentrations of heavy metals (under investigation in this paper) were less than levels reported in this paper (Victor et al.; Igbuku, A.U. 2015; Waribo et al., 2015; Anisha et al., 2023). The descrepancies in concentrations may be due differences in sources of samples and differences in sample preparation methods.

For the children risk assessments, the EDI values for all elements (Table 2) were less than their Rfd values indicating that no health risk is associated for consuming these dried seafoods. The HQ (Table 3) and HI (Table 4) values do not indicate any health risk because they were less than 1.

For the adult risk assessment, the EDI values (Table 2) were less than their Rfd values indicating that no health risk is associated with the consumption of these dried seafoods. The HQ (Table 3) and HI (Table 4) values do not indicate any health risk because they were less than 1.
The EDI (Table 2), HQ (Table 3) and RI (Table 5) values for Cd and Ni in Samples A, B, C, and were not computed because concentration of these metals were below detection limits.
The risk index (RI) values (which represents the probability of developing any type of cancer over a lifetime) are given in Table 5. When RI is $> 10^{-4}$ and RI is $< 10^{-4}$, the probability of developing cancer over a lifetime is considered respectively significant and insignificant. The RI values of Cr in all samples were significant for both children and adults and Pb in all samples were insignificant for both children and adults. Cd and Ni in samples A - D were not computed because there concentrations were below detection limit. The RI values of Cd were significant in all samples except in sample E. The RI values of Cr were significant in all samples except in samples E and G.

Table 3. EDI values of metals in crayfish samples

	EDI VALUES Concentration in mg/kg							
	Cr	**Pb**	**Cd**	**Ni**	**Zn**	**Fe**	**Cu**	
A	3.19E-03	9.90E-06	**	**	1.01E-03	2.09E-03	9.02E-04	Children
	2.08E-03	6.44E-06	**	**	6.55E-04	1.36E-03	5.87E-04	Adult
B	8.05E-04	8.10E-06	**	**	2.48E-03	8.65E-04	1.83E-03	Children
	5.24E-04	5.27E-06	**	**	1.62E-03	5.63E-04	1.19E-03	Adult
C	2.40E-03	1.35E-05	**	**	4.80E-04	1.43E-03	1.73E-04	Children
	1.56E-03	8.79E-06	**	**	3.12E-04	9.31E-04	1.12E-04	Adult
D	9.24E-04	3.60E-06	**	**	1.96E-03	4.07E-03	1.05E-03	Children
	6.02E-04	2.34E-06	**	**	1.28E-03	2.65E-03	6.81E-04	Adult
E	2.33E-03	2.69E-03	4.50E-05	1.03E-04	2.29E-03	4.51E-03	1.99E-03	Children
	1.52E-03	1.75E-03	2.93E-05	6.68E-05	1.49E-03	2.94E-03	1.30E-03	Adult
F	3.93E-03	1.39E-03	5.85E-04	1.12E-03	4.37E-03	6.18E-03	2.92E-03	Children
	2.56E-03	9.06E-04	3.81E-04	7.30E-04	2.84E-03	4.02E-03	1.90E-03	Adult

	EDI VALUES Concentration in mg/kg Cr	Pb	Cd	Ni	Zn	Fe	Cu	
G	8.09E-03	5.70E-03	1.79E-03	1.26E-05	3.08E-03	6.31E-03	3.61E-03	Children
	5.26E-03	3.71E-03	1.16E-03	8.20E-06	2.00E-03	4.11E-03	2.35E-03	Adult
H	5.23E-03	5.29E-03	1.99E-03	1.12E-03	1.12E-03	3.79E-03	2.69E-03	Children
	3.40E-03	3.44E-03	1.30E-03	7.27E-04	7.26E-04	2.47E-03	2.53E-03	Adult

** = No EDI values because Cd and Ni levels were below detection limits Samples A, B, C, and D.

Table 4. HQ values of metals in crayfish samples

HQ VALUES	Cr	Pb	Cd	Ni	Zn	Fe	Cu	
A	0.063	0.002	**	**	0.003	0.006	0.023	Children
	0.693	0.001	**	**	0.002	0.0048	0.015	Adult
B	0.268	0.002	**	**	0.008	0.002	0.046	Children
	0.175	0.001	**	**	0.005	0.002	0.030	Adult
C	0.800	0.003	**	**	0.002	0.004	0.004	Children
	0.520	0.002	**	**	0.001	0.003	0.003	Adult
D	0.308	0.001	**	**	0.007	0.011	0.026	Children
	0.201	0.0001	**	**	0.004	0.007	0.017	Adult
E	0.777	0.673	0.045	0.001	0.008	0.013	0.050	Children
	0.507	0.438	0.029	0.001	0.005	0.008	0.033	Adult
F	0.310	0.348	0.585	0.006	0.015	0.017	0.073	Children
	0.853	0.227	0.381	0.004	0.009	0.011	0.048	Adult
G	0.697	0.425	0.790	0.001	0.010	0.018	0.090	Children
	0.753	0.928	0.160	0.001	0.007	0.011	0.059	Adult
H	0.743	0.323	0.990	0.005	0.004	0.011	0.067	Children
	0.133	0.860	0.300	0.004	0.002	0.007	0.063	Adult

** = No HQ values because Cd and Ni levels were below detection limits Samples A, B, C, and D.

Table 5. HI values of metals in crayfish samples

HI VALUES		
A	0.066	Children
	0.695	Adult
B	0.270	Children
	0.176	Adult
C	0.803	Children
	0.522	Adult
D	0.309	Children
	0.201	Adult
E	0.495	Children
	0.974	Adult
F	0.248	Children
	0.464	Adult
G	0.912	Children
	0.841	Adult
H	0.061	Children
	0.297	Adult

** = No HI values because Cd and Ni levels were below detection limits Samples A, B, C, and D.

Table 6. RI values of metals in crayfish samples

RI VALUES					
	Cr	**Pb**	**Cd**	**Ni**	
A	1.596E-03[a]	8.420E-08 [b]	**	**	Children
	1.039E-03 [a]	5.470E-08 [b]	**	**	Adult
B	4.030E-04 [a]	6.890E-08 [b]	**	**	Children
	2.620E-04 [a]	4.480E-08 [b]	**	**	Adult
C	1.200E-03 [a]	1.150E-07 [b]	**	**	Children
	7.810E-04 [a]	7.470E-08[b]	**	**	Adult
D	4.620E-04 [a]	3.060E-08 [b]	**	**	Children
	3.010E-04 [a]	1.990E-08 [b]	**	**	Adult
E	1.164E-03 [a]	2.280E-05 [b]	1.710E-05 [b]	9.370E-05 [b]	Children
	7.580E-04 [a]	1.490E-05 [b]	1.110E-05 [b]	6.080E-05 [b]	Adult
F	1.966E-03 [a]	1.180E-05 [b]	2.220E-04 [a]	1.021E-03 [a]	Children
	1.279E-03 [a]	7.700E-06 [b]	1.450E-04 [a]	6.640E-04 [a]	Adult
G	4.044E-03 [a]	4.840E-05 [b]	6.790E-04 [a]	1.150E-05 [b]	Children
	2.632E-03 [a]	3.150E-05 [b]	4.420E-04 [a]	7.460E-06 [b]	Adult
H	2.615E-03 [a]	4.490E-05 [b]	7.570E-04 [a]	1.020E-03 [a]	Children
	1.702E-03 [a]	2.920E-05 [b]	4.930E-04 [a]	6.620E-04 [a]	Adult

** = No RI values because Cd and Ni levels were below detection limits Samples A, B, C, and D.
[a] = RI > 10^{-4} and [b] = RI < 10^{-4}

CONCLUSION

The health risk indices (Estimated Daily Intake, Hazard Quotient, Hazard Index, and Risk Index) of heavy metals indicate that dried crayfish samples sold in markets in Bayelsa State are safe for consumption.

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