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HEALTH RISKS ASSESSMENT OF HEAVY METALS IN NOODLES SOLD IN OZORO, DELTA STATE, NIGERIA

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ABSTRACT
The concentrations of some selected heavy metals were assessed by atomic absorption spectrophotometry in noodles sold in the study area. Total of eight different brands of noodles were investigated. The results of heavy metals in samples in mg/kg were in the order: Fe (13.15 – 144.75); Pb (0.00 – 0.55); Cd (0.00 – 0.01); As (0.00 – 0.14); Ni (0.01 – 0.09); Cu (0.02 – 0.33); Zn (1.45 – 8.05) and Cr (0.06 – 0.25). Estimates of daily intakes of metals and health risk index for noodles revealed that the local consumers were safe but were at risk of potential bioaccumulation arising from dietary of Ni, Cd, Cu, Zn in some samples.

Keywords: *Noodles, Heavy metals, Ozoro,Average daily intake, Human health risk*

INTRODUCTION

There is a growing interest in trace/heavy metals and health risk assessment at mining sites and foodstuff across the globe using different techniques (Odumo *et al*., 2011a; 2011b; Kamunda *et al.,* 2016; Wang *et al.,* 2005). The food industry is attracting serious attention on heavy metals due to increasing cases of contamination in agriculture and sea food sources. Also, heavy metals find their way into food during the processing chain.

The pasta industry is growing very fast due to global consumption of noodles. Noodles are produced from rice or wheat flours with other additions such as seasoning, pepper, chicken pieces, salts etc. it lacks some nutritional components such as dietary fiber, therefore it is necessary to add lentil to increase the fiber content.

Previous documentations from Bangladesh, Pakistan and China revealed that wheat and rice from which noodles are made contains heavy metals (Jothi and Uddin, 2014; Huang *et al.,* 2013; Singh *et al.,* 2010; Zeng *et al.,* 2015). Cadmium and lead have been reported to be among the most abundant heavy metals that are toxic. Cadmium and lead exposure may cause kidney and skeletal damage to human body (WHO, 1992; 1995).

Onyema *et al.,* (2014) reported the presence of heavy metals and proximate analysis on instant noodles sold in Nigeria markets. Five common brands of instant noodles were sampled and analysed for proximate and heavy metals using standard analytical methods. The results revealed that Fe and Zn in the samples were within allowable limits of WHO (2003) while Cd, Cr, As, Mn, Ni and Pb occurred at levels slightly above the permissible limits of WHO. Hou and Kruk, (1998) and Omuku *et al.,* (2014) also reported the presence of heavy metals in noodles.

This present study assessed some heavy metal concentrations in noodles and the potential health risks it may pose to the consumers. Suitable models were adopted to estimate the ADI and HRI.

MATERIAL AND METHODS

Study Area

The study area lies within the Niger Delta sedimentary basin which is characterized by both Marine and mixed continental quaternary sediments that are composed of abandoned beach ridges and mangrove swamps (Anoliefo, 1991). The area lies on latitude 5^0 33’23’’N and longitude 6^0 14’58’’E. The area experiences wet and dry seasons which are typical seasons in Nigeria (Eteng-Inya, 1997; Etu-Efeotor, 1998).

Ozoro is the headquarters of the Isoko North Local Government Area, one of the two administrative units in the Isoko region of Delta State, southern Nigeria. The main economic activity is food crop farming accompanied by some hunting. The staple food crops include cassava and yams. Cassava is the source of most of the food consumed by the Ozoro people. *Garri*, starch meal (*Ozi*) and *Egu* are cassava derivatives. The people are very hospitable. It is one of the largest communities in Isoko land, both in terms of size and population. Ozoro has several schools the most notable one is the Delta State Polytechnic, Ozoro (https://en.wikipedia.org/wiki/Ozoro).

Sampling

A total of eight available brands of noodles were purchased from Ozoro markets in Etevie and main markets and were taken to the laboratory for analysis.

Preparation and digestion of samples

The samples were removed from sachet using a clean scissors and were crushed and ground to fine power on a porcelain crucible.

Digestion of samples was done by a procedure prescribed by ASTM D 1971-95B. 1g of samples with 5ml of Nitric acid and 5ml of Hydrochloric acid was taken in duplicate in flasks with few drops of deionised water added and then heated in a fume hood until the sample was homogenized and brown fumes ceased to evolve. The solution was allowed to cool at room temperature and filtered through whatman filter paper

no.42. Then the volume of the filtrate was made up to 100ml with distilled water for AAS reading. Digestion of blank was also performed in parallel with samples keeping all digestion parameters the same.

Data analysis

Average daily intake of metals (ADI)

Daily intake of noodles in adult and child were estimated by equation (1)

$$ADI = \frac{C_m x D_{fI}}{B_{Awt}} \quad (1)$$

where C_m is heavy metal concentration in noodles (mg kg^{-1}), D_{fI} is average daily intake of noodles (Kg/person), and B_{Awt} average body weight (Kg/person) (Wang et al.2005). The average daily noodle intake for adults and children were estimated to be 0.345 and 0.240 kg/person.day respectively. Body weight for adults was taken as 65kg and children average body weight was estimated to be 35.5kg. The heavy metal intakes were compared with permissible limits for daily intakes for heavy metals set by (WHO, 1993).

Health risk index (HRI)

The knowledge of exposure pathway to the receptor is necessary to be able to assess the health risk of heavy metals to human body. In the present study noodles sold in the market were purchased and the heavy metal concentrations were used to compute the health risk index. HRI values depend on the daily intake of metals (ADI) and oral reference dose (Rf_D). Oral reference dose is an estimated per day exposure of metal to the human body that has no harmful effect during life time (USEPA IRIS, 2006).

The HRI for Cu, Fe, Ni, Zn, Pb, Cd, As and Cr due to consumption of noodles was calculated using equation (2) established by USEPA (1999):

$$HRI = \frac{ADI}{R_{fD}} \quad (2)$$

where ADI has been earlier defined and R_{fD} represents oral reference dose. R_{fD} value for Cu, Fe, Ni, Zn, Pb, Cd, As and Cr is 0.04,0.007,0.02,0.30,0.004, 0.001,0.0003,1.50 (mg/kgbw/day) respectively (USEPA, 2006; 2005). Health risk assessment of contaminants was based on the values of HRI. HRI value that is less than 1 implies no risk and values greater than 1 indicate greater risk level.

RESULTS AND DISCUSSION

Table 1 shows the level of heavy metal concentrations in different brands of noodles sold in the study area. The mean concentrations of all heavy metals ranged from 0.00 -144.75mg/kg. Iron ranged from 13.15-144.75mg/kg and cadmium ranged from 0.00-0.01mg/kg. While other heavy metal values ranged 0.02-0.33, 0.01-0.09, 1.45-8.05, 0.00-0.55, 0.01-0.14 and 0.06-0.25mg/kg for copper, nickel, zinc, lead, arsenic and chromium respectively.

In all samples, the concentration of level of Cr were found to be above WHO permissible limits which are similar to the findings of Onyema et al. (2014). Pb in GPML, GPT and CNS samples were above the WHO permissible limits for Pb. Apart from Cd, Zn and Cu that were within the permissible limits Fe, Pb, Cr and As were above allowable limits set by (WHO, 2003). Our results were slightly higher than those reported in other parts of Nigeria.

Health risk to adults and children

The health risk index (HRI) as shown in Table 2, were less than 1 in adults and children for most metals which indicated that there was no potential risk both the adults and children. However, HRI for Fe in all samples were greater than 1 which implies that the children are at a greater health risk than adults of the same population. Arsenic in some samples has high value of HRI.

Table 1: Heavy metal concentration in noodles sold in the study area

	Heavy metals concentrations in noodles purchased from Ozoro markets in mg/kg							
Brand of noodles	Cu	Fe	Ni	Zn	Pb	Cd	As	Cr
GPML	0.23	46.05	0.02	7.60	0.55	0.00	0.14	0.17
GPT	0.33	144.75	0.09	8.05	0.52	0.01	0.10	0.12
GPS	0.16	13.15	0.03	6.25	0.00	0.00	0.13	0.06
CN	0.06	65.80	0.01	3.65	0.01	0.00	0.05	0.25
CNS	0.08	39.45	0.08	2.20	0.25	0.01	0.05	0.11
ICN	0.05	46.30	0.05	3.45	0.00	0.00	0.03	0.12
DN	0.06	52.65	0.04	2.95	0.00	0.00	0.01	0.09
MGCN	0.02	26.30	0.01	1.45	0.00	0.00	0.01	0.11
WHO[a] limits	NA	10 -50	NA	5 - 22	0.025	0.003	NA	0.05

a (WHO, 2003) NA= not available

Table 2. Health risk assessment of some metals in samples

Brand	Metal	R_{fD}	ADI_{adult}	ADI_{child}	HRI_{adult}	HRI_{child}
	Cu	0.04	0.0012208	0.001555	0.030519	0.038873
	Fe	0.007	0.2444192	0.311324	34.91703	44.47485
	Ni	0.02	0.0001062	0.000135	0.005308	0.006761
	Zn	0.3	0.0403385	0.05138	0.134462	0.171268
GPML	**Pb**	0.004	0.0029192	0.003718	0.729808	0.929577
	Cd	0.001	0	0	0	0
	As	0.0003	0.0007431	0.000946	2.476923	3.15493
	Cr	1.5	0.0009023	0.001149	0.000602	0.000766
	Cu	0.04	0.0017515	0.002231	0.043788	0.055775
	Fe	0.007	0.7682885	0.978592	109.7555	139.7988
	Ni	0.02	0.0004777	0.000608	0.023885	0.030423
GPT	**Zn**	0.3	0.0427269	0.054423	0.142423	0.181408
	Pb	0.004	0.00276	0.003515	0.69000	0.878873
	Cd	0.001	5.308E-05	6.76E-05	0.053077	0.067606
	As	0.0003	0.0005308	0.000676	1.769231	2.253521
	Cr	1.5	0.0006369	0.000811	0.000425	0.000541
	Cu	0.04	0.0008492	0.001082	0.021231	0.027042
	Fe	0.007	0.0697962	0.088901	**9.970879**	**12.7002**
	Ni	0.02	0.0001592	0.000203	0.007962	0.010141
GPS	**Zn**	0.3	0.0331731	0.042254	0.110577	0.140845
	Pb	0.004	0	0	0	0
	Cd	0.001	0	0	0	0
	As	0.0003	0.00069	0.000879	**2.3**	**2.929577**
	Cr	1.5	0.0003185	0.000406	0.000212	0.00027
	Cu	0.04	0.0003185	0.000406	0.007962	0.010141
	Fe	0.007	0.3492462	0.444845	**49.89231**	**63.5493**
	Ni	0.02	5.308E-05	6.76E-05	0.002654	0.00338
CN	**Zn**	0.3	0.0193731	0.024676	0.064577	0.082254
	Pb	0.004	5.308E-05	6.76E-05	0.013269	0.016901
	Cd	0.001	0	0	0	0
	As	0.0003	0.0002654	0.000338	0.884615	1.126761
	Cr	1.5	0.0013269	0.00169	0.000885	0.001127
	Cu	0.04	0.0004246	0.000541	0.010615	0.013521
	Fe	0.007	0.2093885	0.266704	**29.91264**	**38.1006**
	Ni	0.02	0.0004246	0.000541	0.021231	0.027042
CNS	**Zn**	0.3	0.0116769	0.014873	0.038923	0.049577
	Pb	0.004	0.0013269	0.00169	0.331731	0.422535
	Cd	0.001	5.308E-05	6.76E-05	0.053077	0.067606
	As	0.0003	0.0002654	0.000338	0.884615	**1.126761**
	Cr	1.5	0.0005838	0.000744	0.000389	0.000496
	Cu	0.04	0.0002654	0.000338	0.006635	0.008451
	Fe	0.007	0.2457462	0.313014	**35.10659**	**44.7163**
	Ni	0.02	0.0002654	0.000338	0.013269	0.016901
ICN	**Zn**	0.3	0.0183115	0.023324	0.061038	0.077746
	Pb	0.004	0	0	0	0
	Cd	0.001	0	0	0	0
	As	0.0003	0.0001592	0.000203	0.530769	0.676056
	Cr	1.5	0.0006369	0.000811	0.000425	0.000541
	Cu	0.04	0.0003185	0.000406	0.007962	0.010141
	Fe	0.007	0.27945	0.355944	**39.92143**	**50.84909**
	Ni	0.02	0.0002123	0.00027	0.010615	0.013521
DN	**Zn**	0.3	0.0156577	0.019944	0.052192	0.066479
	Pb	0.004	0	0	0	0
	Cd	0.001	0	0	0	0
	As	0.0003	5.308E-05	6.76E-05	0.176923	0.225352
	Cr	1.5	0.0004777	0.000608	0.000318	0.000406
	Cu	0.04	0.0001062	0.000135	0.002654	0.00338
	Fe	0.007	0.1395923	0.177803	**19.94176**	**25.4004**
	Ni	0.02	5.308E-05	6.76E-05	0.002654	0.00338
	Zn	0.3	0.0076962	0.009803	0.025654	0.032676
MGCN	**Pb**	0.004	0	0	0	0
	Cd	0.001	0	0	0	0
	As	0.0003	5.308E-05	6.76E-05	0.176923	0.225352
	Cr	1.5	0.0005838	0.000744	0.000389	0.000496

*Bold figures indicate high health risk values

CONCLUSION

The presence of As and Cr in concentration levels in the samples and high values of HRI in most samples might pose serious health effects in the immediate and long time accumulation of these heavy metals in the human body.

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