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Investigation of availability of metals in some brands of canned fish stored in brine and sun-flower oil, sold in Nigeria

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Abstract
Toxicological and environmental concerns have prompted interest in the investigation of toxic elements in food. Concentrations of some heavy metals namely; Iron (Fe), Manganese (Mn), Nickel (Ni), Zinc (Zn) and Vanadium (V) were determined for canned fish products from different countries but sold and consumed in Nigeria, using Benin City, Edo State as a case study. The determination was carried out by inductive coupled plasma - optical emission spectrometer (ICP-OES).
The monthly mean concentration values ranged between 0.2696mg/kg – 10.5628mg/kgFe, 8.8931mg/kg – 22.9468mg/kgZn, 0.0654mg/kg - 0.2554mg/kgMn. These values were below the set values by Federal Drug Agency (FDA), Committee on Medical Aspects of Food and Nutrition Policy (COMA), World Health Organization (WHO), The EU Scientific Committee for Food (SCF), US National Research Council (NRC) Safe and Adequate Daily Dietary Intakes (SADDIs). Monthly mean concentration of Nickel was 0.5442 – 2.1291mg/kg and was below WHO/FEPA set limits except in Unico. Vanadium average monthly values ranged between 0.0399mg/kg - 0.1252mg/kg during this study.
Based on individual brands, John west sardine in brine, Star kist in sun flower oil, Tuna flakes in brine and Unico had Fe concentrations which exceeded the permissible value of 0.30 mg/kg by WHO but below COMA's set values of 8.7 and 6.7 mg/kg for males aged 11-18 and 19+ years respectively. It can therefore be inferred from this study that the storage media is not necessarily a major issue of concern when considering metal contamination, as all the brands in the different storage media used during the period of study were undeniable sources of Fe, Mn, Ni and V.
Conclusively therefore, metals in canned fish though inadvertently is meeting some human dietary requirements in Nigeria and other parts of the world, must be monitored comprehensively and periodically with respect to safe guarding the consumer's health as their elevated levels are capable of causing anemia, brain, kidney, skin, central nervous systems damage among others.

Keywords: Canned fish, Metals, Brine, Sun-flower oil

Introduction
The annual demand for fish in Nigeria is about 2.66 million metric tons, while local production is barely above 600,000 metric tons. This leaves a shortfall of about 2.060 million metric tons (Tokula, 2009) [1], this deficit is met by mass importation of fish and fish by-products. With the population of Nigeria on the rise, there is a corresponding increase in the demand for imported fish in Nigeria, usually in the form of fresh frozen fishes from industrial fishing countries of the world; and many of the imported fish is in canned forms. The quantity of imported both frozen and canned form is estimated to be about 1.01 million metric tons valued at about 984 Million US Dollars or 295.2 Billion Naira (Federal Department of Fisheries, 2008) [2]. In 2011 the ministry of agriculture reported a total canned fish importation valued at 97 billion naira, a value which have tripled with the current economic realities worldwide.
Fish constitutes over 40% of the animal protein intake in Nigeria, making a very significant contribution to its nutrition as the cost of other animal sources have astronomically increased (Federal Department of Fisheries, 2008) [2]. Fish is a rich source of lysine, sulphur, amino acid and is therefore suitable for complementing high carbohydrate diet commonly consumed in Nigeria (Azam *et al*., 2004; Akinwumi, 2011) [3, 4].
The main route of exposure to toxic elements is through food, and the increasing worries about food safety have stimulated researches on the associated risk with the consumption of metal contaminated food (Radwan and Salama, 2006).

Heavy metals are one of the more serious pollutants in our natural environment due to their toxicity, persistence and bio-accumulation problems, and canning which serve as a source of preservation cannot be certified free of metal contamination (Tam and Wong, 2000) [7].

Researches on the quality of sold canned fish products with regards to pollutant level has attracted the attention of nutritionist, fisheries experts and some food standard maintaining bodies, as according to Olowu *et al*. (2009), the range between the beneficial and toxic levels are very small. Determination of the safety level of this food becomes pressing to ensure consumers are educated with the quality of what they consume, storage condition during the holding periods before sales and the probable health risk if any.

This study was therefore undertaken to determine if there were heavy metal contaminants in the canned fishes stored in brine and sunflower oil sold in Edo State, determine if there were variations in the level of heavy metal concentration based on their storage medium and compare levels found against set safe standards by Committee on Medical Aspects of Food and Nutrition Policy (COMA), World Health Organization (WHO), The EU Scientific Committee for Food (SCF), US National Research Council (NRC) Safe and Adequate Daily Dietary Intakes (SADDIs) in ingested substances either in food or supplements by man.

Materials and Methods

Sample Collection

A total of four different brands of canned fish products samples imported from different countries were purchased from different markets and supermarkets in Benin City, Table1 below shows some of the data taken from the collected canned fish samples.

Table 1: Records of collected canned fish product during the period of study

Brand name	storage medium	Weight (g)	Species canned	Expiration Date	Manufacture countries
Unico	Sunflower oil	185	Skipjack tuna	3/2017	Thailand
Star Kist	Sunflower oil	170	Tuna flake	10/2017	Ghana
Best	Brine	185	Skipjack tuna	5/2017	Thailand
John west	Brine	120	Sardine	6/2017	Portugal

Preparation of canned fish sample for digestion

In the laboratory, the canned fish preservative medium (sunflower oil and brine) were carefully decanted, rinsed with deionised water and oven dried to constant weight at a temperature of 80^0C for 72hours. Each sample in three replicates per brand/month was milled separately to powder form using a porcelain mortar and pestle. They were stored in labeled plastic packs, sealed and stored at -10^0C prior to digestion and analysis during the period of study.Fish samples were digested using the organic extraction technique described by Sreedevi *et al.* (1992) [8].

Statistical Analyses

Data obtained were analyzed using computer software (Genstat Version 8.1). One way analysis of Variance (ANOVA) test was used in all cases to test for significant differences between means at 5% probability level. Significant treatment means were separated using the New Duncan's Multiple Range Test.

Results

Concentrations of these metals detected in the canned fish brands and in the different months of study are as shown in Tables 2 and 3 below.

Concentrations of the study metals in all the four canned fish brands analyzed differed from each other monthly and differences also existed based on their storage medium. Tuna flake had the highest concentration of iron (11.826 mg/kg), zinc (28.952 mg/kg) nickel (2.2516mg/kg) and magnesium (0.2701mg/kg), while Star Kist had the highest value of 0.1482mg/kg V respectively. The least value of Fe (1.7700mg/kg), Zn (4.335 mg/kg) and Ni (0.5795mg/kg) were obtained in John west, while the least value of 0.0514mg/kg Mn was recorded in Unico as shown in Table 2.

Table 2: Mean and standard deviation of concentrations of metal (mg/kg) in the different brands.

Canned Fish brands	Fe	Zn	Mn	Ni	V
John west in brine	1.7700 ± 0.4825^a	4.3335 ± 0.8370^a	$.0695 \pm 0.0190^a$	$.5795 \pm 0.1579^a$	$.0224 \pm 0.0060^a$
Tuna flakes in brine	11.8260 ± 3.5147^c	28.9527 ± 6.5299^c	$.2701 \pm 0.0802^c$	2.2516 ± 0.6692^d	$.0869 \pm 0.0259^b$
Star kist sunflower oil	8.1042 ± 2.2069^b	19.8410 ± 3.8249^b	$.1852 \pm 0.0504^b$	1.5430 ± 0.4202^c	$.1482 \pm 0.0404^c$
Unico in sunflower oil	2.2439 ± 0.6441^a	5.4932 ± 1.1669^a	$.0514 \pm 0.0147^a$	1.0636 ± 0.3054^b	$.0164 \pm 0.0048^a$
Total	5.9860 ± 4.7044	14.655 ± 11.0142	$.1440 \pm 0.1017$	1.3594 ± 0.7510	$.0685 \pm 0.0591$

Note: Different superscripts in the same column are significantly different

Table 3: Mean and standard deviation of concentrations of study metals (mg/kg) in different months

Month	Fe	Zn	Mn	Ni	V
January	4.3352 ± 3.23333^a	11.7920 ± 8.79445^a	0.1045 ± 0.06901^a	0.9846 ± 0.48373^a	$.0496 \pm .04095^a$
March	4.8821 ± 3.64109^{ab}	13.1493 ± 6.81276^a	0.1175 ± 0.07760^a	1.1087 ± 0.54476^a	$.0558 \pm 0.4617^a$
May	5.8585 ± 4.36933^{ab}	13.2794 ± 9.90377^a	0.1410 ± 0.09309^{ab}	1.3304 ± 0.65382^a	$.0670 \pm .05538^a$
July	6.1129 ± 4.55879^{ab}	15.9352 ± 11.88462^a	0.1469 ± 0.09713^{ab}	1.3883 ± 0.68197^a	$.0700 \pm .05784^a$
September	8.7412 ± 6.51927^b	18.9896 ± 14.16231^a	0.2103 ± 0.13878^b	1.9852 ± 0.97536^b	$.0999 \pm .08278^a$
Total	5.9860 ± 4.70441	14.6551 ± 11.01425	0.1440 ± 0.10166	0.1440 ± 0.10166	$.0685 \pm .05908$

Note: Different superscripts in the same column are significantly different

In the months of study (January – September, 2015) the highest concentration of all the metals were recorded in September, while their least concentrations occurred in the month of January as shown in Table 3 above. The results

obtained were statistically tested using Analysis of Variance (ANOVA) for significant difference and a further separation of means using the Duncan Multiple Range Test (DMRT) between canned fish brands; it was observed that there was a significant difference (p>0.05) in the metal contents of the different brands (Table 2) as Tuna flakes in brine tended to have the highest concentration of all the tested metal except for V, and this was closely followed by Star kist brand stored in sunflower oil Among the months of study (Table 3), similar observation was noted as there was a significant difference (p>0.05) in the metal contents in the different months. During the study, V was not significantly different ranging between 0.496 – 0.999mg/kg, March to May for all the metals were also not significantly different (p>0.05) But January was significantly different (p>0.05) from September.

Discussion

The subject of heavy metal is receiving increasing popularity in food industry due to increasing incidents of contamination in agricultural and seafoods. The ingestion of food is an obvious means of exposure to metals, not only because many metals are natural components of food stuffs, but also due to environmental contamination and contamination during processing (Voegborlo *et al*., 1999) [9].

Heavy metals are significant either from the viewpoint of their essentiality or their toxicity, low or high trace elements imbalances can be considered as risk factors for several diseases. As all the metals in all the studied brands with differing values from set standards was present.

The EU Scientific Committee for Food considered a 'safe and adequate intake' level of Mn to be 1-10 mg/person/day. Results obtained from the analysis showed a maximum Mn concentration of 0.514mg/kgMn and a minimum value of 0.0695mg/kgMn, the mean monthly concentration of Mn as obtained in this study was 0.1749 mg/kg, which was below the recommended values by the US National Research Council (NRC) Safe and Adequate Daily Dietary Intakes (2001) [10] of 0.3-1, 1-3 and 2-5mg/day for infants, children and adults respectively, Manganese concentrations range of 0.0695mg/kg-0.514mg/kg obtained in this study is below the 5.13 mg/Kg obtained by Itodo and Itodo (2010) [11] in their study when working with Geisha canned fish products in Nigeria.

Values obtained from this study exceeded the results of Iwuoha *et al*. (2013) [12] in their study on Geisha and Founty brand of canned fish where they obtained 0.0028mg/kgMn and 0.0016mg/kgMn concentration respectively. It should be noted that manganese levels in foods may also be affected by food processing method.

Iron is a vital component for human life and the human body contains 60-70µg g^{-1} of iron. Most importantly, the Fe compounds, especially haemoglobin and myoglobin which are essential for human survival.

There is no data suggested by Nigeria standard for the acceptable value of ferrous concentrations, but results obtained from this work exceeded the permissible value of 0.30mg/kg set by WHO. Estimated average daily iron requirements in the UK differ between age groups and sexes with the highest requirement of 11.4mg for women in the 11-50 years age group and the least value of 1.3mg for children between 0 – 3months age group (COMA, 1991) [13].

Nickel (Ni) act as activator of some enzyme systems but its toxicity at higher levels is of concern, accumulating in the lungs and frequently causing bronchial failure. All the values obtained during this study were below 3.0mg/kg set by WHO/FEPA (2008) [14] for Nickel limits in foods. Nickel range of 11.0636mg/kg-0.5796mg/kg observed during this study do not agree with 0.238mg/kg by Maduabuchi *et al*. (2008) [15] when they worked with canned fish in tomato paste in Nigeria, and the valuesobtained during this study were higher than results obtained by Malakootian *et al*. (2011) [16] and the means of tested samples of canned fish in Iran (Etem *et al.,* 2012) [17].

The maximum zinc level permitted for fish is 50mg/kg according to Food Codex; this value exceeded those obtained in this study in Tuna flakes (Table 2). However, Zn content of Star kist and tuna flakes exceeded the 5.5-9.5mg/kg/day UK set nutritional intake (RNI) ranges requirement set by COMA (1991) [13] for zinc. The results obtained from this work exceeded the values obtained in canned tomato samples by Etem *et al.* (2012) [17], also 2.987mg/kg recorded in canned fish in southern Iran (Malakootian *et al*., 2011) [16]. The US Recommended Daily Allowance (RDA) is 15mg/day for adult males and 12mg/day for adult females. These set levels of zinc, however are higher in comparison to the levels obtained in John West and Unico brands analyzed.

Vanadium is released to the atmosphere primarily as simple or complex vanadium oxides and some sulphates (International Programme on Chemical Safety, 2001) [10]. Releases of vanadium to the environment are mainly associated with industrial sources, especially oil refineries and power plants using vanadium rich fuel oil and coal. Value so obtained during this study were all below the 2mg/kg set by WHO/FAO, the values were also lower than 2.9mg/kg set by FDA.

Conclusion

Food chain contamination by metals (heavy and trace) has become a burning issue in recent years because of their potential accumulation in bio-systems through contaminated water, food, soil and air.

Storage media did not significantly affect Unico and John west stored in sunflower oil and brine respectively, but there was a significant difference in the metal concentration in Tuna flakes and Star kist stored in brine and sunflower oil respectively. Thus it can be inferred from this study that the storage media did not result in much significant difference but this difference could be more related to brand. Which could be linked to polluted environment from production country, contamination during the canning process; the equipment used during processing, packaging and ambient storage temperature prevalent in Nigeria which is in the tropics

Therefore routine monitoring and management programs for levels of metals in all canned fish brands sold in the country will contribute to improving food safety and potential food pollutants. To form a reliable reference for healthy canned fish product consumption among Nigeria consumers, as this will facilitate evaluation of possible health hazards. Provision of continuous information on levels of environmental pollution in the production country must be carried out and made available should the need arise as economic/business partners.

References

1. Tokula G. Federal Department Fisheries In: FAO regional workshop on rice and aquaculture for productivity increase and market development in West Africa. 2009, 23-27.

2. Federal Department of Fisheries. Fisheries Statistics of Nigeria projected human population; fish demand and supply in Nigeria 2000-2015, 56.
3. Azam K, Ali MY, Asaduzzaman M, Basher MZ, Hossain MM. Biochemical assessment of selected fresh fish. Journal of Biological science. 2004; 4:9-10.
4. Akinwumi FO. Evaluation of some plant materials for the control of smoked fish pest, *Dermestes maculates* DeGeer (Coleoptera: Dermestidae) in *Clarias gariepinus* Burchell (Pisces: Claridae) ARPN Journal of Agricultural and Biological Science. 2011; 6(7):65.
5. El Diwani G, El Rafie SH. Modification of thermal and oxidative properties of biodiesel produced from vegetable oils. International Journal of Environmental Science and Technology. 2008; 5(3):391-400.
6. Idrees FA. Assessment of trace metal, distribution and contamination in surface soils of Amman. Jordan Journal of Chemistry. 2009; 4(1):77-87.
7. Tam NFY, Wong YS. Spatial variation of heavy metals in surface sediments of Hong Kong mangrove swamps. Environmental Pollution. 2000; 110:195-205.
8. Sreedevi PA, Suresh A, Siraramkrishna B, Dehevi H. Bioaccumulation of nickel in the organ of the fresh waterfish (*Cyprinus carpio)* and the water mussel (*Lamenthoders marginals)* under lethal and sub lethal nickel stress. Chemosphere. 1992; 24(1):29-36.
9. Voegborlo RB, El-Methnani AM, Abedin MZ. Mercury, cadmium and lead content of canned tuna fish. *Food Chemistry* 1999; 67(4):341-345.
10. International Programme on Chemical Safety. Vanadium pentoxide and other inorganic vanadium compounds. Concise International Chemical Assessment Document29, World Health Organization, Geneva, Switzerland, 2001. http:// www.who.int/ipcs/publications/cicad/en/cica d29.pdf.
11. Itodo UA, Itodo UH. Estimation of toxic metals in canned milk products from unlaquered tin platted cans. Journal of American Science. 2010; 6(5):173-178.
12. Iwuoha GN, Uporo VB, Onwuachu UI. Variation of Heavy Metals in Canned Geisha and Founty Mackerel Fish Brands Obtained from Choba Market Port Harcourt, Nigeria. Journal of Applied Science Environmental Management. 2013; 17(4)577-580.
13. COMA. Committee on Medical Aspects of Food and Nutrition Policy: Dietary Reference Values for Food Energy and Nutrients for the UK. HMSO, London, 1991.
14. Agency for Toxic Substance and Disease Registry (ATSDR). Draft Toxicological Profile for Cadmium U.S. Department of Health and Humans Services, Public Health Humans Services, Centers for Diseases Control. Atlanta, 2008. http://www.atsdr.cdc.gov
15. Maduabuchi JU, Christine NN, Ese OA, Orish EO. Iron, manganese and nickel exposure from canned foods in Nigeria: a public health concern. Journal of Health Science. 2008; 54(2):335-338.
16. Malakootian M, Tahergorabi M, Daneshpajooh M, Amirtaheri KC. Determination of Pb, Cd, Ni and Zn concentrations in canned fish in Southern Iran. Journal of Environmental Studies. 2011; 1(1)**:**94-100.
17. Etem O, Ibrahim IO, Gosseling D, Memduh SO. Determination of heavy metals concentration in tomato growth in different station types, Romanian Biotechnology Call Letter. 2012; 17(1):6962-6974.