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Assessment of heavy metals in brands of canned fishes stored in vegetable oil marketed in Benin city, Nigeria

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Abstract: This study was undertaken to ascertain the safety level of consuming canned fish as it relates to metals. Seven commonly consumed canned fish brands stored in vegetable oil sold in Benin-City were bought from super stores and in the open markets and stored at ambient temperature between January to September, 2015. A total of 106 samples were collected and analysed in triplicates for iron (Fe), zinc (Zn), manganese (Mn), nickel (Ni) and vanadium (V); which were detected in all the canned fish samples but V had an average of 0.024mg/kg value during the study which was just a detection level. The heavy metal variation ranged between 2.21-21.38mgFe/kg, 5.41-52.35mgZn/kg, 0.05-0.72mgMn/kg, 0.42-7.00mgNi/kg and 0.02-0.16mgV/kg respectively during the period of study. Generally, heavy metal concentration increased with increasing storage time especially Fe and Zn. There was significant difference in the mean concentration of the heavy metal levels evaluated during the period of study in the different brands ((p>0.05). The Laser, Soil and Titus sardines were significantly higher. However, all the metal concentrations were not significantly different (p>0.05) from the permissible set limits by Food and Agriculture Organization (FAO), World Health Organization (WHO) and European Union (EU) legislation for fish except for nickel. Effort must therefore be made to comprehensively and intermittently monitor metal levels on arrival and during long time storage of canned fish. As this will not only help to safeguard the health of the citizenry but the point at which metal contamination occurs can be effectively deduced and appropriate measures could then be taken to prevent metal contamination.

Keywords: Assessment, Canned fish, Metals, Nigeria, Vegetable oil

INTRODUCTION

Fish is widely consumed in many parts of the world by humans because it has high protein content, low saturated fat and also contains Omega 3 fatty acids known to support good health. Globaly, per capita fish consumption have risen to over 20kg/yr in 2016, against an average of 9.9kg, 14.4kg and 19.7kg in 1969's, 1990's and 2013 respectively (USEPA, 2004; FAO, 2016). Nigeria requires about 3.32 million metric tons for consumption annually based on the 2014 population estimate of 180million people, producing only 1.1million metric ton and having to import over 2million MT of fish and fish products. In 2014 alone it was reported by the department of Fisheries Statistics (2016) that Nigeria imported over 8,000 metric tons of fish and fish products. Fish and other aquatic life forms are found in water that is constantly exposed to chemicals, pollutants and other contaminants. Fish may be contaminated by toxic elements during growth, 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 systems because they occupy different tropic levels and are of different sizes and ages (Goyer, 1994). Food safety demand therefore, being a major public concern worldwide during the last decade, has stimulated researches regarding the risk associated with consumption of foodstuffs contaminated by different classes of contaminants.

Investigation of heavy metals in canned fishes and dietary intakes of toxic elements from canned fishes sold in Edo State Nigeria are limited, it becomes necessary to carry out this study to determine and ascertain the state of heavy metal levels of canned fishes and fish products preserved in the vegetable oil imported and sold in the Nigeria market; particularly in Edo State. This study was therefore undertaken to compare heavy metal contents of the different make of canned fishes and also compare these data with the set safe standard levels set by FAO and WHO, whose standards are adopted presently in Nigeria

MATERIALS AND METHODS

The study was carried out in Benin City, Edo state, Nigeria, approximately 25miles north of the Benin River. Benin City was established in the 13th century and the city has an estimated population of 1,147,188 people (Census, 2006). Seven different types of canned fish products samples imported from different coun-

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tries were obtained from retail supermarkets and open market in the State. The analysis of collected samples was done between January - September 2015. Table 1 show the names, storage medium and other information collected and recorded from the label on the can brand samples purchased in SuperStores and open market in Benin City, and used for this study

All reagents used were of analytical grades unless where stated otherwise, and all digestion and analysis were carried out according to AOAC (1995). The experiment was done in triplicates and data obtained were analyzed using computer software (SPSS version 21), one way analysis of variance (ANOVA) at significant differences between means at 5% probability level. Duncan's Multiple Range Test was used to analyze the significant difference between homogenous subsets and the data are reported as mean values ± standard deviation (Freud *et al*., 1997).

RESULTS AND DISCUSSION

The ingestion of seafood is an obvious means of exposure to heavy metals, especially fish because they occupy different trophic levels with different sizes, age, season and habitat (Burger *et al.,* 2002). However, due to advances of new packaging technology especially the use of cans with lacquered walls and mechanical seam, reduces or in most cases eliminates the leaching of heavy metals (Fe, Zn, Mn, Ni and V) into food. Results from this study showed the occurrence of Fe, Zn, Mn, Ni and V in all seven canned fishes stored in vegetable oil purchased in open markets and supermarkets in Benin-City, Edo State, Nigeria during different months of the year (Table 2).

Iron is an important constituent of hemoglobin, myoglobin and enzymes like xanthine, carbon monoxide hydrogenase among others, estimated daily iron requirements for children 0 – 10 years ranges between 1.3mg and 6.7mg. Estimated daily requirements in the U.K are 8.7 and 6.7mg for males aged 11-18 and 19+ respectively (COMA, 1991). For women aged 11-50, the estimated average daily iron requirement is 11.4mg while for postmenopausal women is 6.7mg. The FAO/WHO recommended ≥18mg /day for women during their reproductive life. Iron content observed during this study and that obtained during similar study by Iwuoha *et al.* (2013) in Rivers state, Nigeria;were similar. The daily FAO/WHO recommended requirement was only exceeded by Laser sardines (21.38mg/kg) (Table 3).

Zinc is widespread among living organisms, due to its biological significance and has been implicated in most metabolic pathways in humans; its deficiency can lead to loss of appetite, growth retardation, skin changes and immunological abnormalities. The maximum zinc level permitted for fish is 50mg/kg according to Food Codex (MAFF, 1993), this value is lower than those obtained from this work whose maximum was 52.35mg/kg in Laser sardines. However, zinc content of Soil sardines and Titus sardines exceeded the U.K required nutritional intake (RNI) ranges set by COMA for zinc of 5.5-9.5mg/kg/day. According to Celik and Oehlenschlager (2006), the highest zinc concentration in Turkish canned fish samples was 33.8mg/kg but work done by Mendil *et al.* (2005) in Lake Tokat Turkey gave level of zinc as 48.6mg/g. The results from these findings are in agreement with other findings where 34.0mg/kg have been observed in canned anchovy and 7.5mg/kg in canned sardine (Tuzen, 2009). Amount higher than the tolerable limit of zinc may result in decreased absorption of dietary carbohydrate and induce apoptosis in the cell line according to Sensil *et al*. (2009). As intercellular zinc has been shown to accumulatein different tissues and cell type as either as a consequences of exogenous administration or release from intracellular stores by reactive oxygen species or nitrosation that could lead to induced cell death by inhibition of the energy metabolism (Tyszka *et al*., 2014).

The mean monthly concentration of Mn during this study was 0.27mg/kg and was below the recommended value of 1-10mgMn/person/day and 0.3-1, 1-3 and 2-5mgMn/day for infants, children and adults respectively by the EU Scientific Committee for food (EU-SCF) and the US National Research Council (NRC). However, Titus sardine, Laser sardine and Soil sardine can be said to meet the Mn requirement for infants. Manganese concentration range of 0.05mg/kg to 0.09mg/kg obtained in this study is below the corresponding maximum level reported for canned sardines in Brazil which was 15.77mg/day (Tarley *et al.*, 2001). Daily intake of 2mg Manganese is essential for growth and good health in children as children as well as adults, who lose the ability to remove excess manganese from their bodies, develop nervous system problems, although there are no information on the carcinogenicity of manganese according to EPA (ATSDR, 2004). It should be known that manganese levels in foods may also be affected by method of processing.

All analyzed canned fish samples had high concentration levels of nickel, which has been implicated in respiratory problems when high amounts accumulate in the lungs causing bronchial failure. It acts as an activator of some enzyme systems but its toxicity at higher levels is of great concern (ATSDR, 2004).

Result obtained from this study for vanadium was lower than that obtained by Ikem and Egiebor (2005) with values of V ranging between 0.0-0.31mg/kg. The upper tolerable intake level of vanadium for adults (19 -70years) is 1.8mg/day and there are no data available for other age groups (Institute of Medicine, 2003).

This study has shown that all the analyzed metals were present in all the canned fishes at varied concentrations although V was almost below detection level. Considerable differences were found in the levels of these

Table 1. Record of different canned fish product used for study.

Brand name	Storage medium	Weight (g)	Fish species canned	Common name of fish used	Manufacturing country	Expiring date of products
Napa Valley	Vegetable oil	170	Flake tuna	Albacore tuna	Thailand	07/2017
Laser	Vegetable oil	125	Sardine	Albacore white tuna	Morocco	06/2017
Founty	Vegetable oil	125	Sardine	South African sardine	Morocco	12/2017
Titus	Vegetable oil	125	Sardine	True sardine	Morocco	06/2017
Geisha	Vegetable oil	125	Sardine	South African sardine	China	07/2017
Soil sardine Costa	Vegetable oil	125	Sardine	True sardine	China	09/2017

Table 2. Concentrations of the metals of products stored in vegetable oil within the months of January – September 2015, Benin City Nigeria.

	Metals (mg/kg)				
Month	**Fe**	**Zn**	**Mn**	**Ni**	**V**
January	6.30 ± 1.45^{d}	17.14 ± 3.95^{c}	0.19 ± 0.05^{c}	1.52 ± 0.43^{c}	0.05 ± 0.01^{c}
March	7.10 ± 1.64^{bcd}	19.31 ± 4.45^{bc}	0.22 ± 0.05^{bc}	1.71 ± 0.49^{bc}	0.06 ± 0.01^{bc}
May	8.52 ± 1.96^{bc}	19.31 ± 4.45^{bc}	0.26 ± 0.06^{bc}	2.05±0.58bc	0.07 ± 0.01^{b}
July	8.89 ± 2.05^{b}	23.17 ± 5.34^{ab}	0.27 ± 0.07^{b}	2.14 ± 0.61^{b}	0.07 ± 0.01^{b}
September	12.71 ± 2.93^{a}	27.61 ± 6.36^{a}	0.39 ± 0.10^{a}	3.06 ± 0.87^{a}	0.10 ± 0.02^{a}

Means within the same column having different superscripts are significantly different (P<0.05).

Table 3. Mean values of selected metals (µg/g) in different brands of cannedfish between January – September 2015, Benin City Nigeria.

	Metals (mg/kg)				
Canned Fish	**Fe**	**Zn**	**Mn**	**Ni**	**V**
Founty Sardine	2.21 ± 0.13^{e}	5.41 ± 0.22^{e}	0.05 ± 0.00^{c}	0.42 ± 0.02^{f}	0.03 ± 0.02^{de}
Laser Sardine	21.38 ± 1.24^{a}	52.35 ± 2.09^{a}	0.49 ± 0.03^{b}	7.00 ± 0.41^{a}	0.16 ± 0.01^{a}
Geisha Sardine	2.34 ± 0.14^{e}	5.73 ± 0.23^{e}	0.09 ± 0.00^{c}	0.45 ± 0.03^{f}	0.03 ± 0.00^{de}
Soil Sardine	12.58 ± 0.74^{c}	30.80 ± 1.26^{c}	0.72 ± 0.04^{a}	2.40 ± 0.14^{c}	0.09 ± 0.04^{c}
Costa Sardine	3.08 ± 0.18^{d}	7.53 ± 0.30^{d}	0.07 ± 0.00^{c}	0.59 ± 0.03^{de}	0.04 ± 0.00^{d}
Titus Sardine	17.00 ± 1.02^{b}	41.62 ± 1.79^{b}	0.39 ± 0.02^{b}	3.24 ± 0.19^{b}	0.12 ± 0.00^{b}
Tuna Flakes	2.35 ± 0.14^{e}	5.75 ± 0.23^{e}	0.05 ± 0.00^{c}	0.60 ± 0.03^{d}	0.02 ± 0.00^{e}

Means within the same column having different superscripts are significantly different (P<0.05).

metals among the different brands but were in compliance with the recommended standards set by FAO, WHO and EU legislation for fish and fishery products except the concentration of zinc in Laser sardines which was above 50mg/kg set limit (Table 3). Nickel concentration was above the permissible limit set by FAO, WHO and EU legislation as this metal if not having carcinogenic effect could lead to respiratory problems. Exposure to metals by fish is mainly through their food intake and by absorption from the water column. Laser sardine was observed to have the highest concentration of these metals but it was lowest in Founty sardine, Giesha sardines and Napa valley tuna flakes.

Conclusion

These canned fish samples now considered relatively safe for consumption, over prolonged consumption period could become unsafe and could lead to chronic accumulation of metals in the kidney and liver of humans causing disruption of numerous biochemical processes, as fish consumption is not meant to act as a supplement.Therefore, too frequent consumption of canned fish should be discouraged as this may result in bioaccumulation of the metals and increase health risks. More research and assessments of seafood qual-

ity is needed in Nigeria to make available data that will help safeguard the health of the populace.The countries of production should enact and enforce laws that will monitor production chain; prevent the dumping of untreated domestic and industrial effluents into the aquatic environment.

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