

Probabilistic Risk Assessment of Canned Meat Consumptions In Bayelsa State, Nigeria

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Abstract

Food of animal origin provides important nutrients (protein, zinc, iron, selenium, vitamins and phosphorus) that constituted a well-balanced diet. The meat food industry employs numerous technologies such as canning to prolong shelf life, ease distribution and preserved quality. Unfortunately, the meat canning process has raised public health concerned over the safety and quality of the products due to the exposure of man to toxic elements (heavy metals). This survey determines the content of Cadmium, Chromium, Copper, Iron, Tin, Lead, Mercury, Manganese, Nickel and Zinc in canned meat by means of ICP-MS apparatus and mercury analyzer; perform Probabilistic Risk Assessment (non-carcinogenic) using Tolerable Daily Intake (TDI); Target Hazard Quotient (THQ) and Health Risk Index (HRI)mg/kg-bw/day. The analysis shows that Sn, Hg and Fe were below recommended limits; Cd and Cu were also within limits except in Costa and Exeter products while Cr, Pb, Mn, Ni and Zn were above recommended limits in all products. The TDI recorded nine elements (Cd,Cr,Cu,Fe,Pb,Mn,Ni,Sn and Zn)that were beyond recommended Oral Reference Dose (RfD) in different canned meat. The THQ reveled Cu and Ni above recommended RfD values ($4.0E^{-2}$ and $2.0E^{-1}$) which posed carcinogenic risk effects on the use; however, the overall HRI values of all the heavy metals were below the limits (<1), indicating non-carcinogenic health effects on the exposed populations. Therefore, the consumption of this product should be limited to avert future health risk.

Keywords: Heavy Metals, Canned Meat, Human Health Risks, Potential Carcinogenic Effects, Health Hazards.

Introduction

The human ecosystem is at high risk of relative toxics elements characterized as heavy metals. Their presents is aggravated by the uncontrolled human activities such as farming, technologies, constructions, mining, exploitations, military activities, quarrying etc. and has found its way into the food chain to effect man; therefore human are precipice of her actions.

Human exposure to heavy metals through various routs (oral ingestion in food and water intake, dermal and inhalation) is of public health concerned due to their environmental sustainability and bio accumulative properties. Therefore, improving the nutritional quality

of food is imperative for farmers, food industries, and the general human wellbeing of the consumers. This is because the concentrations of natural and synthetic chemical compounds in food contribute to its safety and it is very important to quantify the traditional nutrients, heavy metals, pesticides and various other constituents for the safety of consumers (Adedokun, *et.al.*, 2016).

Statement of Problem

Human food is classified into five major groups (Fruits and Vegetables, Starchy, Dairy, Protein and Fat) each contained important vitamins and minerals that provide the required amount and types of nutrient substances (micro and macro) for survival. Of the sources of protein; Meat contained of 23% Proteins, ranked among the most significant, nutritious, and favored food items (Ahmad, Imran & Hussain, 2018). Unfortunately, meat is a perishable food; an ideal for the growth of a wide range of pathogenic bacteria and spoilage (Ebuete *et. al.*, 2020). The perishability of meat products now called for canning to prolong shelf life (1-30yrs) (Lewis, 2015); easy transportation and distributions, budget friendly and ease uses, freshness and promote prestige; using metals and alloys; a process that has rendered the products quality with a question mark for safety.

This is because, metallic food packaging is mostly composed of tinplate (tin-coated steel), chromium coated steel, or aluminum materials; customarily coated on the inner side with resin to prevent food products from coming in contact with the metal and toxic trace elements in canned; which has not been totally achieved due to human errors. However, the question of food contaminations may arise from farm, in product processing and through migration from the packaging materials. The latter is of interest especially when corrosion occurs due to the damage of the coating; the food is exposed to metal elements like tin (Sn), iron (Fe), cadmium (Cd) and lead (Pb) (Kassouf *et.al.*, 2013; Fiamegos *et.al.*, 2016). Secondly, most of this product is made and attended to with the temperate climatic conditions but later found their way in the tropical region whose safety and healthiness became of public concerned. In addition, the products handling from region to regions and persons to persons may have altered the foods sensory making consumer vulnerable to arrays of pathogenic diseases. These and many more have make it important to secure lives through the investigation of the potential human health risk of heavy metals intake via consumption of canned meat in Bayelsa State, Nigeria.

Objective of the Study

Life is a precious gift; good health is priceless; therefore, the simple art of eating food should not drive man to an early grave. That is why goal 3 - 'good health and wellbeing' of the United Nations Development Goals clearly expressed on good health and food security. The objective of this study is to determine heavy metals concentrations in selected imported canned meat in Nigeria particularly in Bayelsa state and evaluate the Human Health Risk Exposure of these metals using recommended Assessment Models.

Materials And Methods

Study Area

The study was conducted in Yenagoa, the capital city of Bayelsa State, Nigeria. Yenagoa City is located at the southern part of Nigeria at a coordinates $4^{\circ}55'29''\text{N}$ and $6^{\circ}15'51''\text{E}$, with an area of 706km^2 .

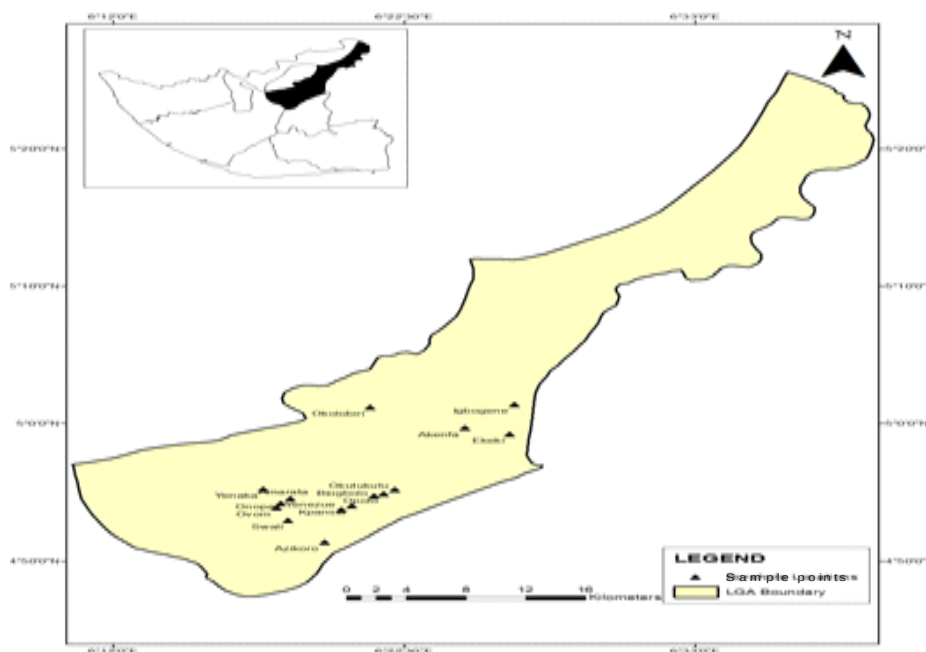


Fig.1. Map of Bayelsa State Showing Yenagoa

Source: Researcher, 2023.

Experimental Material and Sample Preparation.

Research material consisted of Exeter Corn Beef (340g) and Napa Valley Corned Beef (340g) Brazilian products; Zwan Chicken (200g) Netherland; and Zwan Turkey (200g) Turkey products (Table 1). The canned meats (4 assortments from 3 kinds of meat: Beef, Turkey and Chicken) is purchased from the hypermarket in Yenagoa City (year of production 2021); all having a four (4) years shelflife otherwise described as BEST BEFORE. The content of every can was homogenized. The samples were frozen (-20°C), lyophilized in a Labconco freeze dryer (Model 64132, Kansas City, MO, USA) and stored in a desiccator for further use.

Measurement of Water Content

Water content in fresh and freeze-dried samples was determined with the use of a moisture analyzer (Radwag WPS50SW) after drying samples at 100°C. Result was the average of three measurements.

Determination of Heavy Metals (Pb, Cd, Cr, Cu, Mn, Fe, Sn, Zn, Ni and Hg)

Three subsamples derived from the .samples taken from every cane have been analyzed:

about 0.5000g of sample material was weighed directly into a Teflon vessel, 10mL of 65% HNO₃ was added (Suprapur grade, Merck, Germany), and microwave mineralization was performed (Mars 5, CEM Corporation, USA). A blank sample containing only the reagents is attached to every mineralization batch following methods described by Kowalska, Pankiewicz and Kowalski (2020). The microwave mineralization was performed stepwise at 400W and 363 K (4 min), at 800W and 393K (5 min) and at 1600W and 483K (6 min). The cooled digested solution was then diluted to 50mL using high purity deionized water.

ICP-MS Measurements

For determination of Pb, Cd, Cr, Cu, Mn, Fe, Sn, Zn, Ni and Hg in the samples, the inductively coupled plasma mass spectrometer ICP-MS 820- MS (Varian, Mulgrave, Australia) with quadrupole mass analyzer was used. The instrumental conditions for trace elements determination by ICP-MS were as follows: plasma: argon plasma; plasma flow: 18 L min⁻¹; auxiliary flow: 1.8 L·min⁻¹; stealth gas flow: 0.12 L·min⁻¹; nebulizer flow: 0.95 L·min⁻¹; sampling depth: 6 mm; RF power: 1.35 kW; pump rate: 0.1 Hz; stabilization delay: 35s; first extraction lens: 5V; second extraction lens: 190V; third extraction lens: 225V; corner lens: 200V; left mirror lens: 39V; right mirror lens: 34V; bottom mirror lens: 36V; entrance lens: 1.00V; fringe bias: -2.90V; entrance plate: -39V. Calibration curve for each element was prepared using the highest purity standard solutions (1000mg·L⁻¹, 99.999%) from Ultra Scientific. The calibration standards for ICP-MS analysis were prepared by diluting the solutions with 1% HNO₃. The results were expressed in mg·kg⁻¹ of fresh matter. The analytical quality was controlled by means of measurement of a blind sample and a double sample.

Determination of Mercury (Hg) Concentration

Mercury was determined independently using non-flame atomic spectrometry absorption technique (Mercury Analyzer AMA 254, Altec, Czech Republic) according to previously described method (Kowalska, Pankiewicz & Kowalski, 2020). Correct operation of the apparatus was controlled regularly by calibration of standard mercury solutions—NIST-traceable Hg standard solution (Accu Trace Single Element Standard; Accu Standard Inc., New Haven, CT, USA) (Ociepa-Kubicka & Ociepa, 2012).

Human Health Risk Exposure Assessment Models

Models propounded by the United State Environmental Protection Agency (2016) were used to assess adults exposure to heavy metals from processed Canned Meat via oral ingestions. The models include the **Tolerable Daily Intake (TDI)** (Lima et al. 2021; Adedokun et.al. 2016.); **Target Hazard Quotient (THQ)** (Markmanuel, Amos Tautua & Songca, 2022; Adedokun et.al. 2016) and **Health Risk Index (HRI)** mg/kg-bw/day (Kowalska, Pankiewicz & Kowalski, 2020; Dadar et.al., 2017) as expressed in equation 1-3.

2.2.1 **Tolerable Daily Intake (TDI)(mg/kg-bw)**: This is the daily maximum amount of a contaminant an individual may be exposed to over a lifetime without unacceptable risk of health effects as expressed in equation 1.

$$TDI = \frac{IR \times MC}{Bw} \quad (1)$$

Where: IR = Daily Ingestion of Canned Meat

MC = Mean Element Concentrations (mean recorded values)

Bw = Body weight (Average 60kg)

Targeted Hazard Quotient (THQ) (mg/kg-bw): Targeted Hazard Quotient (THQ) is the ratio between human exposures to contaminate and the oral reference dose. This explained about the estimation of non-carcinogenic risk effects; as expressed in equation 2 below. In summary; **THQ>1**, signifies probability of potentially harmful effects occurring (carcinogenic risks), while at **THQ≤1**, signifies no probability of unfavorable effects (Iwegbue, 2011; Markmanuel, Amos-Tautua & Songca, 2022). RfD is the heavy metal oral intake reference dose (mg kg⁻¹ day⁻¹). RfD for Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Sn and Zn is 1.0; 1.5, 4.0, 7.0, 3.5, 1.4, 0.001, 2.0, 0.20 and 3.0mg/kg/day, respectively (Pawełczyk, Bożek, and Zuber, 2018; <https://www.clinmedjournals.org/articles/ijtra/ijtra-6-033-table2.html>).

$$THQ = \frac{EF_i \times ED_i \times FIR \times MC}{RfD \times BW_i \times AT_n} \times 10^{-3} \quad (2)$$

Where: EF: Exposure Frequency (Often 365days)

ED: Exposure Duration (54 Years for Average Nigerians) (Adedokun *et.al.* 2016).

FIR = Ingestion Rate

MC = Average Metal Concentration in Canned Meat

RfD = Oral Reference Dose

BW = Average body Weight (60kg)

AT_n = Average Exposure Times (ED x 365).

Note: If the THQ value is greater than 1(>1), the exposure is likely to cause obvious adverse effects (Adedokun *et.al.* 2016).

Health Risk Index (HRI) (mg/kg-bw): HRI is the health Risk of non-carcinogenic adverse effects due to exposure to contaminants. It is expressed as a ratio of tolerable daily intake of heavy metals in processed canned meat, with the oral reference dose (RfD) as expressed in equation 3.

$$HRI = \frac{TDI}{RfD} \times 10^{-3} \quad (3)$$

Where: TDI = Tolerable Daily Intake

RfD = Oral Reference Dose

Note. HRI values greater than one (>1) implies the exposed population will likely experience potential non-carcinogenic effects (Markmanuel, Amos-Tautua & Songca, 2022).

Results and Discussion

Table 1. Mean Laboratory Analysis of Canned Meat against Recommended Limits (mg/kg)

ELEMENTS	SAMPLES					
	EXETER CORN BEEF	COSTA CORNED BEEF	CORNED BEEF (NAPA)	ZWAN CHICKEN LUNCHEON	ZWAN TURKEY LUNCHEON	MCE (SRLs)
Cadmium (Cd)	0.004	0.011	0.002	0.008	0.002	0.005
Chromium (Cr)	3.092	1.643	5.431	2.814	1.471	0.250
Copper (Cu)	7.133	4.824	3.548	2.051	2.939	4
Iron (Fe)	14.340	8.478	9.538	5.030	7.498	40
Lead (Pb)	2.487	1.891	1.723	2.039	1.302	0.010
Manganese (Mn)	19.017	11.63	15.18	13.06	10.43	1.8
Mercury (Hg)	0.004	0.002	BDL	BDL	0.001	0.003
Nickel (Ni)	3.488	1.198	5.126	2.561	1.914	0.14
Tin (Sn)	9.207	6.139	4.740	2.546	5.834	200
Zinc (Zn)	23.017	17.623	21.028	24.923	15.519	5

Source: Researcher, 2023. Council of Europe Specific Release limits (SRLs) (mg/kg).

Levels of Heavy Metals in Brands of Canned Meat

Various sources of environmental contamination had been implicated as route for heavy metals in food; among which are the ingestion of polluted plants, drinking from polluted water sources, air deposition, spillage, constructions, meat processing and canning. These are major pathways to heavy metals bioaccumulation in meat, which made canned meat hygiene gained immense prominence as a matter of utmost public health concern especially to the meat consumer. The results from the analysis were presented in table 1 and 2 among other variables of health interest.

Cadmium (Cd)

In this survey, the mean concentrations of Cd were 0.004; 0.011; 0.002; 0.008 and 0.002 for Exeter, Costa, Napa, Zwan chicken and Zwan Turkey respectively. The highest Cd concentration was found in Costa Corned beef and Zwan Chicken, which were above limits recommended by Council of Europe Specific Release limits (SRLs) (0.005mg/kg) (Table 1). The addition of spices during production of canned meat could be the reason for the high

concentrations, since spices could contain Cd concentrations up to 200ng/g. Similar with the report of Bakircioglu, Kurtulus and Ucar (2011). The findings also correspond with the reports of Hamasalim and Mohammed (2013) 0.001-0.27; Al-Zuhairi, Farhan, and Ahemd (2015) 0.0579-0.6801.

On the other hand, the computations of the Tolerable Daily Index (TDI) of 2.8g for Cd is very high, however, the Targeted Hazard Quotients (THQ) of $9.3E^{-2}$ and the Health Risk Index of $2.0E^{-3}$ is very minimal not to caused adverse carcinogenic effects (table 2).

Chromium (Cr)

The concentration of Chromium were 3.09; 1.64; 5.43; 2.81 and 1.47mg/kg for Exeter Corn Beef, Costa Corn beef, Corned Beef (Napa), Zwan Chicken and Zwan Turkey respectively in an order of NAPA>Exeter>ZWAN Chicken>Costa>ZWAN Turkey which is above the recommended limits by the Council of Europe Specific Release limits (SRLs) of 0.25mg/kg. This could be likened to the methods of food preparation and storage systems. Korkmaz, *et.al.* (2017) submitted that food products stored in metal containers or cans has the chances of increasing the content of chromium. Similarly, Ojezele *et.al.* (2021) reporting a range of 1.74-2.55 mg/kg in canned mushroom; Kowalska, Pankiewicz and Kowalski (2020) 0.02-0.24mg/kg; Hamasalim and Mohammed (2013) 0.10-0.4mg/kg.

Copper (Cu)

The concentrations of copper range between 2.05mg/kg with Zwan chicken to 7.13mg/kg with Exeter corn beef in an order of EXETER> COSTA>NAPA>ZWAN Turkey ZWAN Chicken (table 1). All the products were within the limits accepted by the **MCE (SRLs)** of 4mg/kg except for products of Exeter corn beef (7.13mg/kg) and Costa Corned Beef (4.82mg/kg) whose possible reason could be traced to meat contamination at farm or folk. Similar results were reported by Ojezele *et.al.* (2021) 0.01-0.41mg/kg. AL-Rajhi (2014) 0.0001-0.0017kg-1; Areej, Angham and Adem (2012) a range of 0.001-0.1ppm; lwegbue (2011) reported 1.1–2.4mg/kg.

Lead (Pb)

Lead concentrations range between 1.302-2.487mg/kg, in an order of EXETER>ZWAN Chicken>COSTA> NAPA>ZWAN Turkey. The values were above the limits accepted by the **MCE (SRLs)** of 0.01mg/kg. This may be attributed to the used of lead solder with a sheet steel cans enclosed with seams, enamel or vinyl protective coatings. Khalafalla *et.al.* (2016) also reported 0.330mg/kg and 0.244 mg/kg with canned chicken luncheon and canned beef luncheon respectively; Alzuhairi *et al.* (2015) reported 0.0953 mg/kg with chicken; Hamasalim and Mohammed (2013) reported 1.19, 1.02, 1.00, 0.52µg/g, in four-canned chicken luncheon; lwegbue (2011) reported 5.001–1.5mg/kg.

Nickel (Ni)

The study revealed Nickel concentration range between of 1.914mg/kg with Zwan turkey to 5.126mg/kg with NAPA Corned Beef in an order of NAPA>EXETER>ZWAN Chicken>ZWAN Turkey>COSTA. All the products were above the recommended accepted limits of 0.14mg/kg by the **MCE (SRLs)**; which can be attributed to the product processing and handling. Similarly, Ojezele *et.al.* (2021) reported 0.55±0.22mg/kg and 0.86±0.17 mg/kg in red kidney (RK) and hot dog (HD) respectively; Iwegbue (2011) reported 0.8–5.9mg/kg for Ni.

Zinc (Zn)

The concentration of Zn in this study range between 15.52-24.92mg/kg, with the highest concentrations found with Zwan Chicken luncheon. The concentration flows in the order of ZWAN Chicken> EXETER>NAPA>COSTA>ZWAN Turkey (table 1) were above the limits accepted by the **MCE (SRLs)** of 5mg/kg (table 1). The presents of ZnO nanoparticles in the lining of the canned food against antimicrobial activities and the staining of sulfur-producing foods may be the possible reasons. Similar studies such as AL-Rajhi (2014) reported 0.0120 for Zn; Hamasalim and Mohammed (2013) reported Zn range of 0.015-3.16mg/kg; Al-Tagafi, Arida and Hassan (2014) reported 24.14-26.76mg/kg and Iwegbue (2011) reported 1.1–8.0mg/kg.

Manganese (Mn)

The concentration of Mn in the current study were 19.017 (Exeter); 11.625mg/kg (Costa); 15.183mg/kg (Napa); 13.055mg/kg (Zwan Chicken) and 10.433mg/kg (zwan Turkey) which flows in an order of EXETER>NAPA> ZWAN Chicken> COSTA>ZWAN Turkey. All the products were above the limits accepted by the **MCE (SRLs)** of 1.8mg/kg (table 1); which can be attributed to meat food source contamination and handling. Similarly, Iwegbue (2011) reported 50.04–0.57mg/kg for Mn, AL-Rajhi (2014) reported 0.0029mg/kg for Mn; Oloruntoba & Nathaniel (2019) reported zinc concentration of 47.75mg/kg in Kidney and 119.5mg/kg for Liver. AL-Rajhi (2014) reported a range of 0.0025-0.0308 mgkg⁻¹ with an average value of 0.0120mg kg⁻¹ in chicken.

Mercury (Hg)

The concentration of mercury in this survey is 0.00354 (EXETER), 0.00193 (COSTA Corned Beef) BDL (NAPA Corned Beef), BDL (ZWAN Chicken Luncheon) and 0.00116 (ZWAN Turkey Luncheon). The concentration of Hg is in an order of EXETER> COSTA>ZWAN Turkey NAPA and ZWAN Chicken. All the products were within the limits accepted by the MCE (SRLs) of 0.003mg/kg (table 1). In a related studies Nava *et.al.*, (2023) reported 118.9, 115.78, 123.56, 116.76µg/kg for Canned beef, Pork, Poultry and Fish respectively; Stojanovic *et.al.* (2021) reported 15.04µg/kg; Khalafalla *et. al.* (2016) reported 0.387 and 0.450mg/kg in

canned chicken luncheon and canned beef luncheon respectively; Areej, Angham and Adem (2012) reported Hg of 0.001-2ppm in canned meat.

Tin (Sn)

The study reported 9.207mg/kg; 6.138mg/kg, 4.740mg/kg, 2.546mg/kg, 5.834mg/kg for EXETER Corn Beef, COSTA Corned Beef, NAPA, ZWAN Chicken and ZWAN Turkey respectively (table 1), in an order of EXETER>COSTA>NAPA>ZWAN Chicken>ZWAN Turkey. The recorded values were above the limits accepted by the **MCE (SRLs)** of 200mg/kg, which could be liken to the dissolution of tin plates at low pH, high temperature and exposure to air. Similarly, Khalafalla *et. al.* (2016) reported 2.061, 2.308, 0.755 and 1.997 mg/kg for canned chicken luncheon and canned beef luncheon respectively.

Iron (Fe)

The Recommended Dietary Allowance (RDA) of Fe is 8.7mg for male and 14.8mg for female of 18+ years. The study recorded the presents of iron in the products with EXETER Corn Beef (14.34042mg/kg); COSTA Corned Beef (8.47861mg/kg); NAPA Corned Beef (9.53751mg/kg) ZWAN Chicken Luncheon (5.03017mg/kg); ZWAN Turkey Luncheon (7.49835mg/kg) (table 1) respectively. The recorded values were within the tolerable limits accepted by the **MCE (SRLs)** of 40mg/kg and flows in the order of EXETER Corn Beef>NAPA Corned Beef>COSTA Corned Beef>ZWAN Turkey Luncheon>ZWAN Chicken Luncheon. Similar results were presented by Leite (2022) 1.466-3.507mg/kg; Iwegbue (2011) 13.8 to 28.8mg kg⁻¹ in various brands of canned beef.

Probabilistic Human Health Risk Assessment Models

Probabilistic human health risk models for adults (18+) exposure to heavy metals via oral ingestions of a processed Canned Meat results is presented in table 2 along with their reference doses; using models like Tolerable Daily Intake (TDI); Target Hazard Quotient (THQ) and Health Risk Index (HRI).

Table 2. Summarized Computed Human Health Risk Exposure Assessment Models (mg/kg)

Parameters	ΣT Conc.	D.I	Max. Limit	RfD	TDI	THQ	HRI
Cd	0.0051	62/70 µg	0.005	1.0E ⁻³	5.2E ⁻³	1.0E ⁻⁶	1.0E ⁻⁶
Cr	2.890	30mg/kg	0.250	1.5E ⁻⁰	2.89	9.3E ⁻²	2.0E ⁻³
Cu	4.099	900	4	4.0E ⁻²	61.49	1.05	1.5E ⁻²
Fe	8.977	12 mg/kg	40	7.0E ⁻¹	1.794	3.8E ⁻²	3.0E ⁻⁴
Pb	1.888	0.47 mg/kg	0.010	3.5E ⁻³	1.5E ⁻²	1.0E ⁻⁴	4.0E ⁻⁷
Mn	13.863	2 mg/kg	1.8	1.4E ⁻¹	0.462	7.6E ⁻²	3.0E ⁻⁴

Hg	0.001	0.6 mg/kg	0.003	$1.0E^{-3}$	$1. E^{-4}$	$2.0E^{-6}$	$1.0E^{-4}$
Ni	2.857	116 mg/kg	0.14	$2.0E^{-2}$	5.524	$1.32E^{-1}$	$3.0E^{-3}$
Sn	5.693	0.3 mg/kg	200	$0.20E^{-1}$	$2.9 E^{-2}$	$1.4E^{-2}$	$2.0 E^{-4}$
Zn	18.422	10 mg/kg	5	$3.0E^{-1}$	3.070	$3.14 E^{-1}$	$1.0 E^{-3}$

Source: Researcher, 2023.

Where: ΣT Conc.=Mean concentrations of Heavy metals; D.I Daily Intake (, RfD=Oral Reference Dose, TDI=Tolerable Daily Intake, THQ=Target Hazard Quotient, HRI=Health Risk Index.

From table 2; the Tolerable Daily Index (TDI) of $5.2E^{-3}$ for Cd is higher than the recommended oral reference dose of $1.0E^{-3}$. However, the Targeted Hazard Quotients (THQ) of $1.0E^{-6}$ and the Health Risk Index of $1.0E^{-6}$ is very minimal not to caused adverse carcinogenic effects (table 2). Therefore, the exposed populations will not be likely experience potential carcinogenic effects, since both values are below the benchmark of 1; similar report with Liang *et.al.* (2019).

Cr from table 2 had a Tolerable Daily Index (TDI) of 2.89 which is far higher than the recommended oral reference dose of $1.5E^{-0}$. However, the Targeted Hazard Quotients (THQ) of $9.3E^{-2}$ and the Health Risk Index of $2.0E^{-3}$ is very minimal not to caused adverse carcinogenic effects (table 2). Therefore, the exposed populations will not be likely experience potential carcinogenic effects, since both values are below the benchmark of >1; similar report with Liang *et.al.* (2019).

Cu from the table 2; scored a Tolerable Daily Index (TDI) of 61.49; so also the Targeted Hazard Quotients (THQ) of 1.05 which are far higher than the recommended oral reference dose of $4.0E^{-2}$ but the Health Risk Index of $1.5E^{-2}$ is very minimal not to caused adverse carcinogenic effects (table 2). Therefore, the exposed populations will not be likely experience potential carcinogenic effects, since both values are below the benchmark of >1; similar report with Liang *et.al.* (2019).

Fe from the table 2; the Tolerable Daily Index (TDI) of 1.794 is higher than the recommended oral reference dose of $7.0E^{-1}$. However, the Targeted Hazard Quotients (THQ) of $3.8E^{-2}$ and the Health Risk Index of $3.0E^{-4}$ is very minimal not to caused adverse carcinogenic effects (table 2). Therefore, the exposed populations will not be likely experience potential carcinogenic effects, since both values are below the benchmark of >1; similar report with Liang *et.al.* (2019).

Pb From the table 2; the Tolerable Daily Index (TDI) of $1.5 E^{-2}$ for Pb is very low and the Targeted Hazard Quotients (THQ) of $1.0E^{-4}$ and the Health Risk Index of $4.0E^{-5}$ is very minimal not to caused adverse carcinogenic effects (table 2). Therefore, the exposed populations will not be likely experience potential carcinogenic effects, since both values are below the benchmark of >1; similar report with Liang *et.al.* (2019).

Mn From the table 2; the Tolerable Daily Index (TDI) of 0.462 for Mn is very low and the Targeted Hazard Quotients (THQ) of $7.6\text{E-}2$ with the Health Risk Index of $3.0\text{E-}4$ is very minimal not to caused adverse carcinogenic effects (table 2). Therefore, the exposed populations will not likely experience potential carcinogenic effects, since both values are below the benchmark of >1 ; similar report with Liang *et.al.* (2019).

Hg. From the table 2; the Tolerable Daily Index (TDI) of $1. \text{E-}4$ for Hg is very low; the Targeted Hazard Quotients (THQ) of $2.0\text{E-}6$ and the Health Risk Index of $1.0\text{E-}4$ is very minimal not to caused adverse carcinogenic effects (table 2). Therefore, the exposed populations will not be likely experience potential carcinogenic effects, since both values are below the benchmark of >1 ; similar report with Liang *et.al.* (2019).

Ni From the table 2; the Tolerable Daily Index (TDI) of 5.524 for Ni and the Health Risk Index of $3.0\text{E-}3$ is very high but the Targeted Hazard Quotients (THQ) of 0.132 is very minimal but are known to caused adverse carcinogenic effects (table 2). Therefore, the exposed populations will likely experience potential carcinogenic effects, since both values were above the benchmark of >1 ; similar report with Liang *et.al.* (2019).

Sn. From the table 2; the Tolerable Daily Index (TDI) of $2.9 \text{E-}2$ for Sn is very low and the Targeted Hazard Quotients (THQ) of $1.4\text{E-}2$ and the Health Risk Index of $2.0 \text{E-}4$ is very minimal not to caused adverse carcinogenic effects (table 2). Therefore, the exposed populations will not be likely experience potential carcinogenic effects, since both values are below the benchmark of >1 ; similar report with Liang *et.al.* (2019).

Zn From the table 2; the Tolerable Daily Index (TDI) of 3.070 for Zn is moderate low but the Targeted Hazard Quotients (THQ) of 0.314 and the Health Risk Index of $1.0 \text{E-}3$ is within the limits of 1 which means the current concentrations of Zn in the study will not cause adverse carcinogenic effects (table 2). Therefore, the exposed populations will not likely experience potential carcinogenic effects, since both values are within the benchmark of >1 ; similar report with Liang *et.al.* (2019).

Conclusions

Meat forms a considerable component diet, providing essential nutrients to large number of people around the world. The chemical composition of meat depends on the kind and degree of the feeding (feeds and Water); therefore, the potent consequences of feeding livestock's with polluted feeds and water challenges the wholesomeness of the meat by exposing man to array of toxic chemicals via bioaccumulation and biomagnifications. The used of canning to prolong shelf life, enhance transportation, distributions and easy uses, has further challenged the quality of the meat products; because of the possible migration of toxic chemicals from the packaging material to meat food; which called for canned meat food safety worldwide. The excessive content of these metals in food is associated with etiology of a number of diseases, especially with cardiovascular, kidney, nervous as well as bone diseases. In addition, they are also implicated in causing carcinogenesis, mutagenesis and teratogenesis.

This survey determine the content of Cadmium, Chromium, Copper, Iron, Tin, Lead, Mercury, Manganese, Nickel and Zinc in canned meat by means of ICP-MS apparatus and mercury analyzer; estimate Probabilistic Risk Assessment (non-carcinogenic) with models like Tolerable Daily Intake (TDI); Target Hazard Quotient (THQ) and Health Risk Index (HRI) all in mg/kg-bw/day. Results shows that the concentrations of Sn, Hg and Fe were below recommended limits by MCE (SRLs (200, 0.003 and 40) in all canned meat products respectively; Cd is also within recommended safe limits except in Costa product ($0.01056 > 0.005$); Cu is also within recommended safe limits except in Exerter ($7.13251 > 4$) and Costa ($4.82349 > 4$) products. Unfortunately, the concentrations of Cr, Pb, Mn, Ni and Zn were above recommended limits in all the products.

In addition, the concentrations of nine (Cd, Cr, Cu, Fe, Pb, Mn, Ni, Sn and Zn) metals on the summarized Tolerable Daily Intake (TDI) were higher than the Oral Reference Dose (RfD) in different canned meat. The Targeted Hazard Quotient (THQ) also recorded two major metals (Cu and Ni) above the recommended RfD values ($4.0E-2$ and $2.0E-1$) which posed carcinogenic risk effects on the use. Interestingly, however the effects depend on the concentration of the metals in the canned meat rather than dose ingested by body weight; but not subconsciously indicating harmlessness as the daily consumption increases. Most importantly, however, the overall recorded Health Risk Index (HRI) in the studied heavy metals were below the limits (< 1), indicating non-carcinogenic health effects on the exposed populations.

Recommendation

Having determined the concentration levels of heavy metals in various canned meat products, it is therefore, recommended that:

- Daily ingestion of the above canned products should be limited to avert possible adverse carcinogenic effects in future.
- An in-house control based on the declaration of compliance, DoC, and supporting documentation with the producers and importers are important prerequisites to limit this contamination and to ensure compliance with the legislation.
- Regularly undertake monitoring and assessment of imported canned food products at an interval by the constituted agencies in the country.
- Regular biometric analysis on canned food be undertake not only at the port of entry but also at the consumer's door step.
- An enabling condition for Investors be created to encourage product productions within the region and in the country.

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