Assessment of Heavy Metals Concentrations in Selected Road-side Fast Foods in Ibadan Oyo state, Nigeria.

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Abstract--Heavy metal toxicity assessment in foods is important for safety measures. Road-side food samples commonly referred to as fast foods are prone to exposure of heavy metals due to environmental pollution mainly from industrial discharge and automobile emission. This research analyses the heavy metal concentrations of some fast foods; roasted plantain (RP), roasted fish (RF), roasted yam (RY), "suya" meat (SM), fried potato (FP), roasted corn (RC), fried bean cake (FBC) and doughnut (DT) obtained from different locations in Ibadan, Oyo state, Nigeria.

Elemental determination of the selected heavy metals was done using iCE 3000 series Atomic Adsorption Spectrophotometer. Mercury and cadmium concentrations were below the detection limit of the AAS used. The mean concentration of lead and copper ranged from 0.032±0.01 – 0.077±0.05 mg/kg and 0.107±0.01 – 0.231±0.14 mg/kg respectively while the mean concentration of zinc and iron ranged from 0.023±0.01 – 0.039±0.04 mg/kg and 0.557±0.20 – 1.808±1.52 mg/kg respectively.

Keywords: Heavy metals, fast foods, toxicity, Ibadan.

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1. INTRODUCTION

The term "heavy metals" has been recently used to refer to metals that exhibit potential human or environmental toxicity [24]. Heavy metals are known to have density higher than that of water [26]. While the toxicity of heavy metals depends on several factors including, but not limited to, the dose, route of exposure and chemical species, they can be heavily influenced by environmental conditions [11], [22], [24], [25].

Food consumed in Nigeria may be a major source of heavy metals toxicity in humans especially children [12]. Level of heavy metals in food samples have been a strong indication of environmental pollution assessment [5], [7], [13], [15], [25].

Eventhough, Fe, Cu and Zn are essential for human health, excessive dietary intake of these metals may result in toxic effects [17].

Lead and Calcium have been associated with cardiovascular, kidney, nervous and bone diseases while acute mercury exposure may damage the lungs [14]. Major sources of heavy metals in the atmosphere are industrial emissions [23].

Food items, especially fast foods, prepared and served in open places are prone to high exposure to heavy metals. Fast foods are categorized as foods that can easily be prepared and served in small quantities. Due to the relatively cheap cost of this category of food and their tasty nature, most people prefer it as a low-cost alternative with the necessary food nutrients.

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Most of the fast foods are prepared in open places, especially in close proximity to urban roads for easy access to consumers.

This research work aims to analyze the heavy metal concentration in some selected fast foods within Ibadan metropolis, Oyo state Nigeria.

2. MATERIALS AND METHODS

Collection of Samples: Roasted plantain (RP), roasted fish (RF), roasted yam (RY), "suya" meat (SM), fried potato (FP), roasted corn (RC), fried bean cake (FBC) and doughnut (DT) were bought randomly from stationary vendors beside urban roads at three locations: Agbowo, Dugbe and Eleyele, which are less than 8 km distance from one another within Ibadan, Oyo state, Nigeria. Field sampling and data collection were in line with standard procedures and practices for environmental data collection (Federal Ministry of Environment, 1991).

Preparation and Digestion of Samples: The selected food samples subjected to oven drying at 500C, after which they were being crushed into powdered form. 1.0 g each of the selected food samples was transferred into digestion tubes. These were then digested under fume cupboard with a 1:2:2 mixture of perchloric ($HClO_4$), sulphuric (H_2SO_4) and nitric (HNO_3) acids respectively. The digested food samples were cooled and made up to 50 mL mark standard flask using deionized water, after which they were filtered into sample bottles.

Determination of Heavy metals: Elemental determination of lead, zinc, iron, copper, mercury and cadmium was done on the digested food samples using atomic absorption spectrophotometer (iCE 3000 Series, Atomic Adsorption Spectrophotometer, Thermo Scientific).

3. RESULTS AND DISCUSSION

Roasted foods (fish, "suya" meat, plantain, and yam) are commonly sold and consumed as ready-to-eat snacks by a large population in the Ibadan Metropolis, Nigeria. The fish samples are usually thawed, scaled, eviscerated, washed in water, and then placed in an open charcoal fire. The "suya" meat is prepared from boneless beef. The meat is sliced into continuous sheets, cut into pieces and staked on sticks and spiced with groundnut oil and other ingredients after which the "suya" meat are arranged round on wire gauze over an open charcoal fire. The roasted plantain is prepared by peeling the plantain covering; then the raw pulps are placed on wire gauze that was an open charcoal fire to roast until they are slightly brown. All these aforementioned food preparation methods were obtained through a one-on-one interview with the roasted food vendors.

TABLE 1: A SUMMARY OF THE CONCENTRATIONS OF VARIOUS HEAVY METALS PRESENT IN THE ROASTED FOOD SAMPLES

Heavy metals	Location	Unit (mg/kg)	RP	RF	RY	SM	FP	RC	FBC	DT
	Agbowo									
Iron			0.138	0.873	1.837	0.563	0.726	0.689	1.863	0.663
Copper			0.099	0.095	0.272	0.127	0.123	0.143	0.133	0.141
Mercury			BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cadmium			BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Lead			0.167	0.027	0.069	0.035	0.041	0.125	0.069	0.068
Zinc			0.036	0.035	0.027	0.034	0.017	0.021	0.024	0.036
	Dugbe									
Iron			0.750	1.102	0.323	0.562	1.582	0.689	1.811	0.683
Copper			0.111	0.115	0.224	0.123	0.136	0.110	0.126	0.099
Mercury			BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cadmium			BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Lead			0.014	0.013	0.023	0.023	0.008	0.019	0.080	0.178
Zinc			0.023	0.011	0.034	0.044	0.028	0.031	0.033	0.032
	Eleyele									
Iron			0.783	1.991	0.892	2.798	0.906	0.899	1.750	0.460
Copper			0.130	0.116	0.197	0.127	0.101	0.117	0.114	0.082
Mercury			BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cadmium			BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Lead			0.049	0.057	0.050	0.154	0.063	0.059	0.077	0.023
Zinc			0.021	0.024	0.020	0.023	0.026	0.035	0.012	0.025

BDL – Below Detection Limit

These metals are often referred to as heavy metals. Certain heavy metals such as lead, cadmium, mercury, arsenic have been identified to be potentially toxic within specific limiting values[6]. Some of them such as nickel, copper, chromium and iron, for example, are essential in very low concentrations for the survival of all forms of life. These are described as essential trace elements. Only when they are present in greater quantities can these like heavy metals lead and chromium which are already toxic in very low concentrations cause metabolic anomalies [21]. Some of these contaminants, especially the heavy metals are cumulative poisons that pose potential hazards and toxicity [14],[19]. The consequence of metal contamination of food can be hazardous to man which makes it imperative to monitor their presence in foods.

TABLE 1: METALS LEVEL IN SELECTED FOOD ITEMS WITHIN IBADAN METROPOLIS, NIGERIA

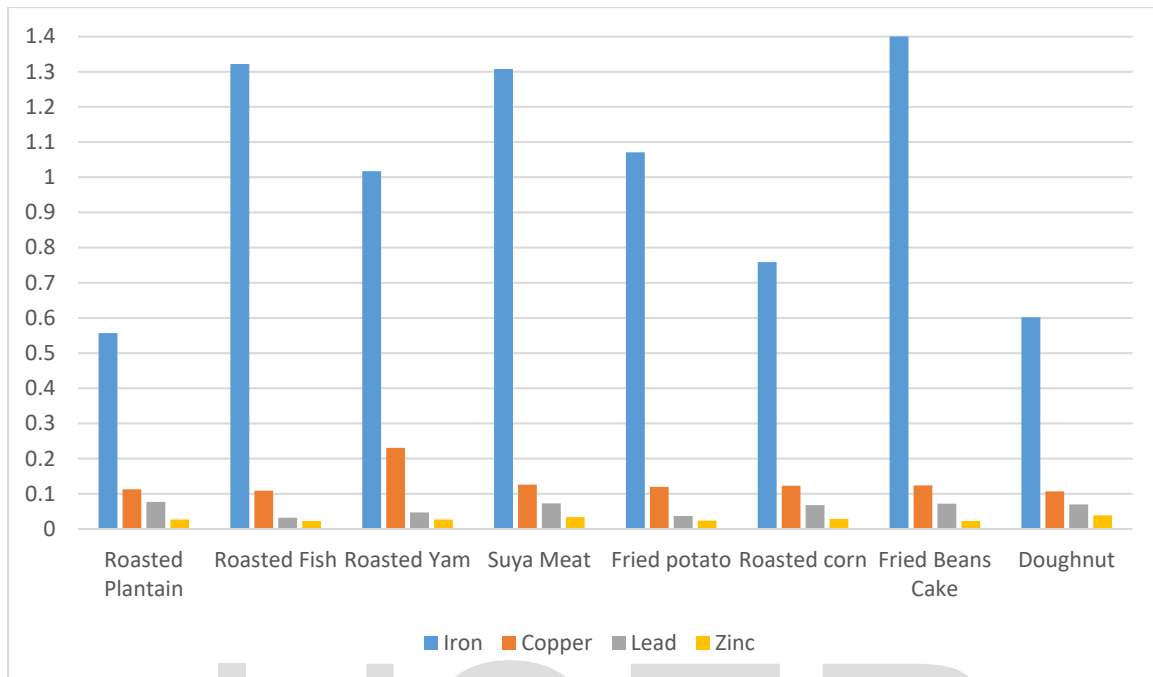| Food items	Heavy Metals (mg/kg)							
	Iron		Copper		Lead		Zinc	
	Range	Mean± SD	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
Roasted Plantain	0.138 – 0.783	0.557±0.26	0.099 – 0.130	0.113± 0.10	0.014 - 0.167	0.077±0.03	0.021 – 0.036	0.027±0.02
Roasted Fish	0.873 – 1.991	1.322±1.52	0.095 – 0.116	0.109± 0.01	0.013 – 0.057	0.032±0.01	0.011 – 0.035	0.023±0.01
Roasted Yam	0.323 – 1.837	1.017± 0.98	0.197 – 0.272	0.231±0.13	0.023 – 0.069	0.047±0.02	0.020 – 0.034	0.027±0.03
"suya" Meat	0.562 - 2.798	1.308± 0.89	0.123 – 0.127	0.126± 0.14	0.035 – 2.798	0.073±0.02	0.023 – 0.044	0.034±0.04
Fried potato	0.726 – 1.582	1.071±0.99	0.101 – 0.136	0.120± 0.13	0.008 – 0.063	0.037±0.03	0.017 – 0.028	0.024±0.02
Roasted Corn	0.689 – 0.899	0.759±0.34	0.110 – 0.143	0.123±0.01	0.019 – 0.125	0.068±0.04	0.021 -0.035	0.029±0.02
Fried beans cake	1.750 – 1.863	1.808±1.20	0.114 - 0.1133	0.124±0.03	0.069 – 0.080	0.072±0.05	0.012 – 0.033	0.023±0.01
Doughnut	0.460 – 0.683	0.602±0.20	0.082 – 0.141	0.107± 0.04	0.023 – 0.178	0.070±0.04	0.025 – 0.036	0.039±0.02

Values are Mean ± SD, n=3

Figure 1: Concentration of selected heavy metals in roasted food items

The concentrations of Hg and Cd in all the food samples in the three locations are estimated to be below the detection limit of the instruments used, atomic absorption spectrometer. The concentration of heavy metals in all the three locations sampled ranged from 0.014 – 0.783 mg/kg, 0.011 – 1.991 mg/kg, 0.020 – 1.837 mg/kg, 0.023 – 2.798mg/kg, 0.017 – 1.582 mg/kg, 0.019 – 0.899 mg/kg, 0.012 – 1.863 mg/kg and 0.025 – 0.683 mg/kg for roasted plantain, roasted fish, roasted yam, "suya" meat, fried potato, roasted corn, fried beans cake and doughnut samples respectively. The mean concentration of lead and copper ranged from 0.032±0.01 – 0.077±0.05 mg/kg and 0.107±0.01 – 0.231±0.14 mg/kg respectively while the mean concentration of zinc and iron ranged from 0.023±0.01 – 0.039±0.04 mg/kg and 0.557±0.20 – 1.808±1.52 mg/kg respectively. With the exception

of mercury and cadmium, other heavy metals – lead, iron, zinc and copper were present in all the food items. The results show that roasted plantain contained the highest concentration of lead, followed by "suya" meat while roasted fish contained the lowest concentration of lead. The concentrations of lead in "suya" meat and roasted plantain from our results which are 0.073 mg/kg and 0.077 mg/kg exceeded the values of lead in "suya" meat and roasted plantain as reported in [2]. The concentrations of lead in all the sampled food items which range from 0.032 – 0.077 mg/kg are generally below the maximum permissible limit set by World Health Organization [3] for Pb in food items which is 0.3 mg/kg. This indicates that there is no consumption risk.

Roasted yam also had the highest concentration of copper, while Doughnut contained the lowest concentration of copper. Fried beans cake contained the highest concentration of Iron, while roasted plantain contained the lowest concentration of Iron. Mercury exposure can cause noxious effects especially in young children and pregnant women. Effects in children include damage to the central nervous system, endocrine system, kidneys and other organs. Long exposure may eventually result in death. All sampled and analyzed food items contained a concentration of mercury below the detection limit of the instrument. The maximum levels of mercury tolerated in food items according to FAO/WHO is 0.1 mg/kg. With our results showing BDL for mercury concentration, this is indicative of no consumption risk related to mercury intake for the consumers.

The maximum limits of cadmium tolerated in food items according to FAO/WHO is 0.05 mg/kg, the concentration of cadmium in the food items is not detectable, that is it is below the regulatory limit set by the FAO/WHO, hence no consumption risk.

All the samples were within the provisional maximum tolerable daily intake of 0.5 mg/kg set by FAO/WHO for copper. Copper is not a cumulative toxic hazard for man, except for individuals suffering from Wilson's disease, also, copper is not considered to be mutagenic, carcinogenic or affect reproduction (FAO/WHO 2011). Even though deficiency and toxicity are rare, chronic ingestion of high amounts of copper may result in liver dysfunction and other adverse effects [4].

The concentration of lead in all the selected samples was lower than the maximum levels of 0.2 mg/kg recommended by FAO/WHO. Regular absorption of small amount of heavy metals such as Lead has been reported to cause health effects in children such as retardation of mental development, deficiency in concentration, adverse effect on kidney function, blood chemistry and cardiovascular system as well as hearing degradation, while high exposure could result in death [20],[18],[1],[19]. All the samples were within the provisional maximum tolerable daily intake of 0.3 mg/kg recommended by FAO/WHO for zinc. However, regular ingestion of high amounts could pose a health risk on human such as vascular shock, dyspeptic nausea, vomiting and diarrhea.

4. CONCLUSION

This study reveals that all the food items: roasted plantain, roasted fish, roasted yam, "suya" meat, fried potato, roasted corn, fried beans cake and doughnut were contaminated with lead, copper, iron and zinc. However, mercury and cadmium are absent in all the selected food items. Roasted plantain, a common delicacy consumed in Ibadan, Nigeria contained the highest level of lead, followed by "suya" meat which is commonly sold across Nigeria by the Northerners. The four heavy metals in the food samples are within the tolerable limits set by FAO/WHO.

However, regular intake of these food items can result in a long-term accumulation which can pose a health risk such as dyspeptic nausea, vascular shock and diarrhea on humans.

These food items are commonly hawked or displayed in open containers under unhygienic conditions which make them prone to contamination with these metals. It is suggested that hygiene preparation, proper storage and display of these foods in covered containers may reduce contamination and prevent an increase in the toxicity level of the metals. Industrial activities should be regulated in order to reduce environmental contamination.

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