Assessment of Heavy Metal Contamination in Vended Road-Side Snacks using Ilorin as a Case Study

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Abstract

Heavy metals are naturally found in the environment being present in human and animal bodies, rock, soil, plant and water. The levels of some heavy metals namely lead, cadmium, copper, zinc and nickel in road-side snacks (puff-puff, bean cake and roasted plantain) commonly sold in Ilorin metropolis were evaluated using Flame Atomic Absorption Spectrophotometer following standard digestion procedure. Samples from four locations characterized by heavy traffic and various human activities (Gaa-Akanbi, Tanke, Taiwo and Post office) were collected and compared with those from a control location characterized by low traffic and less human activities (Unilorin Campus). The levels of heavy metals were generally found to be lower than the permissible limits for the respective metals set by FAO/WHO while statistical analyses revealed a significant difference in lead, zinc and nickel levels for bean cake across the studied locations. The presence of some of these metals can be attributed to the various human activities, vehicular emission, storage containers, methods and ingredients used in the preparation. However, the results indicate that consumption of these road-side snacks may not pose any serious health threat.

Keywords: Heavy metals, Snacks, Contamination, Environment

1.0 Introduction

Food is an essential part of human diet consumed to provide energy, maintain life and stimulate growth. It sustains, strengthens and provides cure and resistance to diseases by repairing and building of tissues in the body [1]. The safety of the food consumed especially with the rate of industrialization and globalization world-wide, calls for urgent attention. Food contaminants from micro-organisms, metals as well as pesticides are present almost at all stages of food production from cultivation, processing, packaging, transportation, storage, marketing and even to the point of consumption [2]. The most predominant and dangerous of these contaminants are metals [2]. Metals are said to be an integral part of human diet, which plays many physical and bio-functional activities in human, plants and animals. They can be classified as macro or micro elements and both are required in the body in little amount. Excessive accumulation of these metals can lead to contamination thereby exposing the body to various diseases and even leading to death in some cases [3].

Some metals are regarded as essential in humans (e.g. Fe, Zn, Cu, Mn, Cr, Mo and Se) whose primary role is to serve as a catalyst; and only trace amounts are required for cellular function. Metals like Pb, As, Cd and Hg are arguably of no known use in the body but can enter the body through inhalation, uptake from soil, water and waste [4].These metals are accumulated as a result of various human activities which include emissions from vehicle exhausts, mining, industrial waste, fertilizer application, paint, treated woods, plastic floating on the world oceans, aging water supply infrastructure, war zones and corrosion of metals [5, 6]. Additional sources of heavy metals in soil are rainfall in atmospheric contaminated area, traffic density, use of oil or fossil fuels for heating, use of plant protection agents and fertilizers [7]. In Nigeria today, the high rate of heavy metal contamination in food results from increase in population, urbanization, uncontrolled dumping of both domestic and agricultural waste, industrial activities and automobile exhaust.

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The World Health Organization [8] defines "street-vended foods" or its equivalent "street foods" as foods and beverages prepared and/or sold by vendors in streets and other public places for immediate consumption or consumption at a later time without further processing or preparation. In Ilorin, there are varieties of street food/snacks consumed by the populace, among them are cocoyam chips (*koko*), plantain chips, roasted yam, roasted plantain, groundnut cake (*kuli kuli*), pounded millet (*fura*), roasted corn, puff-puff, bean cake (*akara*), biscuits, fish pie. Road-side snacks generally serve as food among school children and even elites in the society. Their low cost, taste, convenience and availability make it more appealing to consumers [2]. The verification of the levels of heavy metals in road-side snacks is important because the processing and handling may not be hygienic enough. Furthermore, road-side snacks are usually displayed in trays on road-side without adequate covering thereby exposing them to various environmental pollutants. The objective of this study is to evaluate heavy metals present in the selected food snacks with a view to sensitizing the public on the risk of accumulation of heavy metals in the body.

2.0 Materials and Methods

2.1 Chemicals and Reagents

Analytical grade reagents were used for all analyses and are products of Aldrich Chemical Company, England.

2.2 Collection of Samples and Pretreatment

Bean cake, puff puff and roasted plantain samples were collected randomly from four different locations (Gaa Akanbi, Taiwo, Tanke and Post Office) and one control location (Unilorin Campus) in Ilorin, Kwara State, Nigeria. The samples were collected using aluminum foil paper, transported immediately to the laboratory and cut into bits using a previously cleaned stainless steel knife. Samples were oven-dried separately at 105°C to constant weight and the dried samples were then powdered using mortar and pestle. Glass wares were soaked in 5% nitric acid for 24 h, rinsed with deionized water and oven-dried at 40°C before use.

2.3 Sample Digestion and Metal Analyses

One gram of the powdered samples was quantitatively transferred into a well-glazed porcelain crucible and placed in a muffle furnace at 500°C for 5 h. The resultant ash samples were cooled at room temperature and dissolved with 5 mL of concentrated nitric acid. The solution was then filtered into a calibrated 50 mL volumetric flask using Whatman No. 42 filter paper and made up to mark with deionized water [9]. Flame atomic absorption spectrophotometer (Buck Scientific Model 210) was then used to determine the concentrations of Pb, Cd, Cu, Zn and Ni. Reagent blanks were used in all analyses to check impurities in reagent and other environmental contaminations during analyses. Samples were analysed in triplicates to check for precision of the chosen method and the measuring instrument.

2.4 Statistical Analysis

Statistical Analysis was carried out using SPSS (Statistical Package for Social Sciences) software version 20 (SPSS Inc., Chicago, IL, USA). Analysis of variance (ANOVA) was used to determine the significant difference between the samples.

3.0 Results

The mean concentrations of lead, cadmium, copper, zinc and nickel in the selected snack samples (puff-puff, bean cake and roasted plantain) at various locations in Ilorin metropolis are presented in Figs. 1 to 5 respectively. The mean concentrations of Pb, Cd, Cu, Zn and Ni in all the analyzed samples ranged from <0.001 – 0.167, <0.001 – 0.193, <0.001 – 0.607, <0.001 – 1.09, <0.001 – 0.033 mg/kg respectively. The highest concentration of Pb was recorded in puff-puff at Gaa Akanbi while the lowest concentration was observed in bean cake and puff puff at Unilorin (Fig. 1). Roasted plantain samples at Taiwo location represented the highest concentration of Cd while the lowest was recorded in roasted plantain at Gaa Akanbi and Unilorin locations (Fig. 2). The highest Cu concentration was recorded in bean cake at Gaa-Akanbi location and the lowest level was observed in puff puff from Gaa Akanbi location (Fig. 3). The highest Zn concentration was recorded in puff puff sample at Unilorin location while the lowest was observed in roasted plantain at Post office location (Fig. 4). Nickel was not detected in bean cake at all the locations but was detected in puff puff (Taiwo and Post Office locations) and roasted plantain from Tanke location (Fig. 5). Generally, statistical analysis revealed a significant difference ($p > 0.05$) in Pb, Zn and Ni levels in bean cake across the studied locations.

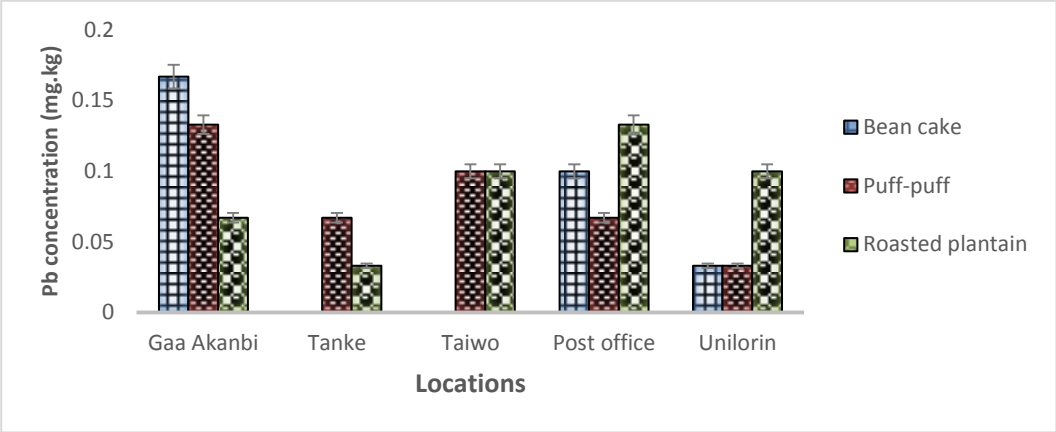

Fig. 1: Mean concentrations of Lead in road-side snacks across the studied locations

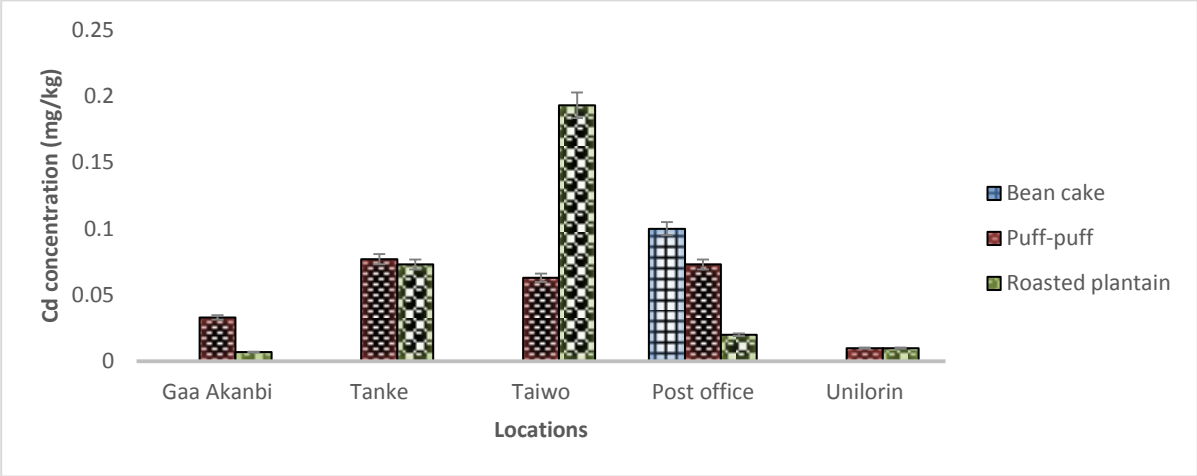

Fig. 2: Mean concentrations of Cadmium in road-side snacks across the studied locations

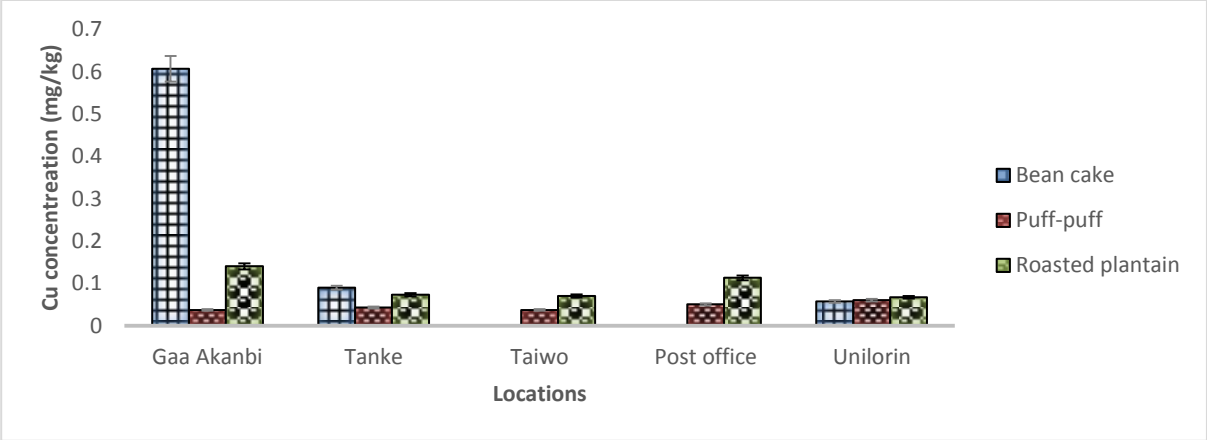

Fig. 3: Mean concentrations of Copper in road-side snacks across the studied locations

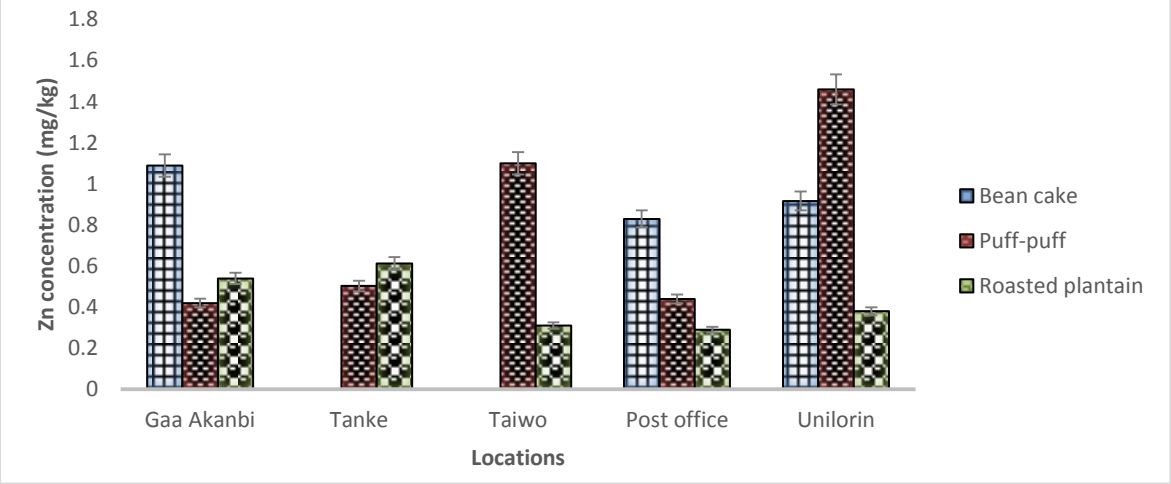

Fig. 4: Mean concentrations of Zinc in road-side snacks across the studied locations

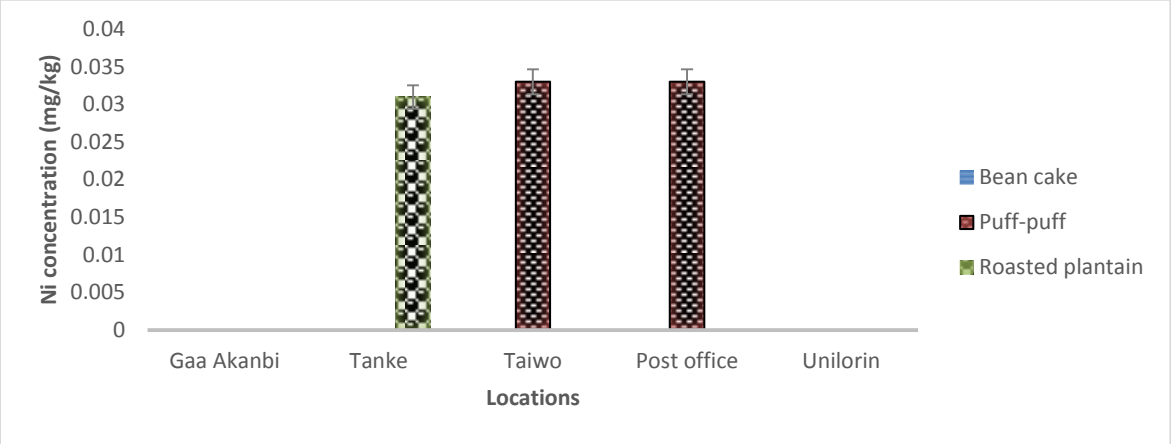

Fig. 5: Mean concentrations of Nickel in road-side snacks across the studied locations

4.0 Discussion

Generally, the contamination of food and drink by metals in areas with high anthropogenic pressure is widespread and it is a major determinant of food quality [10]. The concentration of Pb in all snack samples were found to lower than the permissible limit of 0.2 mg/kg set by FAO/WHO [8]. The concentration of lead in this study is similar to a previous report on metals in ready-to-eat foods [2]. The presence of lead in the snacks may be due to processing, ingredients, handling and preparation methods which usually involves burning of wood. The point of sale (open display of snacks along road-sides) could also be a contributing source in which lead from motor vehicle exhaust gets deposited on the snacks. The health issues associated with lead accumulation in humans include abdominal pain, renal disease, interference with the peripheral nervous system in adult, central nervous system in children and cardiovascular diseases [11]. However, the low levels recorded indicated that the vended snacks may not pose any health threat that could arise from lead consumption.

Cadmium is a metallic element that occurs naturally at low levels in the environment. Cadmium exposure occurs through food, which represent a major route. The data obtained in respect of cadmium revealed that the level of the metal in the vended snacks was higher than the previously reported concentrations in food and drinks [10,13,14]. High level of cadmium in the body is very dangerous, causing bone disorder, cancer of the lungs, anemia and renal damage [15]. Cadmium content of the snack samples were found to be lower than the 0.2 mg/kg permissible limit set by FAO/WHO [8].

The presence of Copper in food samples is likely to be from the soil, especially for cereal products, which is a rich source of the metal and also from water used in processing the food [17]. High Copper concentration was recorded in this study when compared with the values reported by previous researchers [2,16] . However, the concentration was similar to the values reported in some food and drink from Ota in Ogun State Nigeria and roadside Roasted corn and Plantain from Alimosho Local Government Area of Lagos State Nigeria [10,17]. However, the concentrations recorded in the present study showed that the Copper content in the snack samples fell below the permissible limit of 10 mg/kg set by WHO/FAO.

Zinc is an essential nutrient for both plants and animals; and its importance lies in the fact that many body functions are linked to zinc-containing enzymes [18]. High concentration of zinc in control sample of puff-puff may be from water and utensils used in processing. The side effects of consuming excess zinc in human includes vomiting, respiratory disorder after inhalation of zinc smoke, focal neuronal deficits, epigastric pains and diarrhea [19].

High accumulation of nickel in the body may cause damage to liver, kidney, skin and brain. Nickel is also carcinogenic to human causing lungs and nasal cancer on acute exposure [20]. The concentration of nickel in the snack samples across the three locations was below the 0.05 mg/kg permissible limit set by WHO/FAO [8].

5.0 Conclusion

Snacks form an important part of human diets and also represent an important route through which contaminants especially heavy metals enter into human body. From this study, a low level of heavy metal contamination was observed in all of the samples analyzed when compared with the permissible limits set by FAO/WHO. However, the results of this study revealed that the level of contamination of heavy metals from various human activities in the environment in which these snacks were prepared is relatively insignificant which probably accounted for the safety of the snacks for consumption. Nonetheless, adequate routine monitoring and proper hygiene are highly recommended especially at the points processing and sale.

6.0 Acknowledgment

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