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Assessing the Levels of Pb, Cd, Zn and Cu in Biscuits and Home-made Snacks obtained from Vendors in Two Tertiary Institutions in Lagos, Nigeria

***[1]DADA, EO; OJO, ON; NJOKU, KL; AKINOLA, MO**

Department of Cell Biology and Genetics, Environmental Biology Unit, Faculty of Science, University of Lagos, Akoka, Yaba, Lagos, Nigeria.
**Corresponding author:eodada@yahoo.com; eodada@unilag.edu.ng(Tel. +234-7030055768).*

ABSTRACT: The modern day busy schedule of an average individual in Nigeria has made the consumption of snacks inevitable. This study assessed the concentrations of Zn, Cu, Pb and Cd in some common snacks sold in two tertiary institutions in Lagos, Nigeria, using Perkin AAS Elmer model 460. The mean levels of Zn, Cu, Pb and Cd found in plantain chips obtained from the University of Lagos main campus were 2.15 ± 0.13, 0.27 ± 0.03, 0.83 ± 0.04 and 0.10 ± 0.03 mg/kg respectively, while the mean levels of the same metals found in plantain chips obtained from Yaba College of Technology were 1.77 ± 0.57, 0.11 ± 0.04, 1.23 ± 0.61 and 0.08 ± 0.06 mg/kg respectively. Independent-samples t-test analysis revealed that the differences between the mean metal levels in snacks obtained from the two institutions were not significant ($P > 0.05$). Though the levels of most metals in snacks obtained from the two institutions were within the upper limits of the range specified by the World Health Organization, the consumption of snacks with such metal loads over a long period of time may result in metal accumulation in the body beyond tolerable limit. These findings may be a reflection of what obtains in other educational institutions in the country. The authorities of tertiary institutions and other levels of education in Nigeria are therefore called upon to strengthen and widen their internal control mechanisms to guarantee the quality and safety of snacks sold to students and other people on their campuses. ©JASEM

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***Key words*:** Contaminants, Contamination, FAO/WHO, food, snacks, campuses.

Snacks are a form of relatively small, packaged, ready-to-eat fast foods, usually taken not as a regular meal, but as a stopgap. Snacks may be eaten to temporarily hold hunger, or to satisfy a craving. Snacks are often a form of ready-to-eat food, designed to be portable, quick, and satisfying. In Nigeria, the informal food production and marketing system is strong, constituting a prominent source of income for many, especially in cities and urban centres. However, there is a general perception that home-made foods from the informal sector may be unsafe, due to the fear that the environment under which they are prepared might expose the foods to numerous potential contaminants (WHO, 2015). In spite of the fear expressed over foods originating from the informal food production and marketing system, many people in the urban centres including Lagos cannot help eating packaged, home-made snacks due to their busy schedule. Oyelola *et al*. (2013) observed that a large percentage of Lagos dwellers depends on ready-to-eat foods; a situation brought about by a social pattern characterised with increased mobility and urbanization.

Food contamination refers to the presence of potentially harmful chemicals, microorganisms or other substances in a food. Food contaminants are substances that are not usually intentionally added to food, but are present in such foods as a result of the production, manufacture, processing, preparation, treatment, packaging, transport or holding of such foods, or as a result of environmental contamination (Marsh and Bugusu, 2007; WHO, 2015). While the health effects of microbial contamination may be noticed within days or weeks, the effects of chemical contamination may take a long of time to manifest. Examples of chemical contaminants are metals like Pb, Cd, Zn, Hg, Mg, Mn, Cu, Co. Though some of these metals (e.g. Zn, Cu, Co, Mn) are classified as essential elements, when present in the body above certain concentrations, they can become harmful causing various health conditions. Metals like Pb and Cd have no known biological functions and may exhibit toxicological problems even at low or trace concentrations (Iwegbue, 2012; Elham-Elshewey *et al*., 2015). Depending on the type of metal, the health effects of metal poisoning include gastrointestinal disorders, tremor, diarrhoea, paralysis, vomiting, convulsion, diabetes, cancer, anaemia, encelopathy etc (Duruibe *et al*., 2007; Adefris, 2011; Dada *et al*., 2015). Heavy metals disrupt the physiological functions of the body by accumulating in vital organs and glands such as the heart, brain, kidney, bone, and liver (Ray and Ray, 2009). In order to check exposure to food contaminant toxicity, the Agriculture Organization of the United Nations (FAO) and the

**Corresponding author:eodada@yahoo.com*

World Health Organization (WHO) jointly released a list of maximum levels for contaminants and toxins in foods (Codex Alimentarius Commission, 2011). Frequent assessment studies are therefore necessary to determine the safety of foods that are consumed regularly.

Many studies have found metal contaminants above recommended safe levels in many foods that are regularly consumed in Nigeria and other places (Lanre-Iyanda and Adekunle, 2012; Oyelola *et al*., 2013; Elham-Elshewey *et al*., 2015). The consumption of ready-to-eat, fast foods, with its attendant fear of contamination may be more manifest in tertiary institutions generally in Nigeria, and particularly in Lagos in view of the fact that students in some of these schools are usually not officially allowed to cook in their hostels. This study was therefore aimed at assessing the concentrations of Pb, Cd, Zn and Cu in some commonly consumed biscuits and home-made snacks vended in different outlets in two tertiary institutions in Lagos, Nigeria.

MATERIALS AND METHODS

*Description of the study area***:** Two tertiary institutions in Yaba area of Lagos, Nigeria were used for the study; these were (1) University of Lagos, Akoka, Yaba, Lagos, Nigeria, referred to in this study as first institution (2) Yaba College of Technology, Yaba, Lagos, Nigeria, referred to in this study as second institution. University of Lagos (Unilag) lies along Latitude 06.52 and Longitude 03.39. It has a student population size of over 40,000 and staff strength of over 3,000. Yaba College of Technology (Yabatech) lies along Latitude 06.52 and Longitude 03.37. Yabatech has a student population size of about 15,000 and staff strength of about 1,600.

*Sample collection and preparation***:** Biscuits and three packaged, home-made snacks were used for the study; these were doughnuts, plantain chips, potatoes chips. In each institution, each of the snacks was purchased from three outlets chosen at random. They were thereafter taken to the laboratory for heavy metal analysis.

*Sample analyses***:** Each snack sample was digested and subsequently analysed for metals. To digest a snack sample, it was oven-dried at 70 - 80°C for 24 hours, milled and homogenized into a fine powder using an electric blender. From the dried sample, 20.0g was weighed into a conical flask and 40 ml dilute nitric acid was added. The mixture of the sample and nitric acid was heated in a Bunsen burner until all the reddish yellow fumes were expelled. The solution was brought down, allowed to cool, and was filtered into a 10 ml standard flask. The standard flask was made up to mark with de-ionized water and ready for the analysis of metal contents. The solution was analyzed for Pb, Cd, Zn, and Cu using a flame atomic absorption spectrophotometer, AAS, (Perkin Elmer model 460).

Evaluation of data: The data obtained from the AAS metal analyses were subjected to analysis of variance (ANOVA). The mean metal concentrations were compared by the Least Significant Difference (LSD) post hoc method to ascertain which mean was significantly higher. The mean metal levels in snacks obtained from the two institutions were compared by Independent samples t-test. All statistical analyses were done using the SPSS (version 20).

RESULTS AND DISCUSSION

All the home-made snacks and the biscuits sampled in this study were found to contain trace/toxic metals at different concentrations. Table 1 shows the levels of Cu and Zn in snacks obtained from the two institutions. In the first institution (University of Lagos campus), plantain chips had mean Zn and Cu concentrations of 2.15 ± 0.13 mg/kg and 0.27 ± 0.03 mg/kg respectively. These were significantly higher than the corresponding levels of 1.77 ± 0.57 mg/kg Zn and 0.11 ± 0.04 mg/kg Cu found in plantain chips obtained from the second institution (Yaba College of Technology). While the mean level of Zn (2.45 ± 0.52 mg/kg) in potato chips sampled from the second institution was higher than the mean level of the same metal (1.79 ± 0.89 mg/kg) in potato chips obtained from the first institution, the reverse was the case for doughnut and biscuit whose mean Zn levels were higher in the first institution. The mean concentrations of Cu in snacks obtained from the two institutions were within the range of 0.05 to 1.00 mg/kg specified by the World Health Organization (WHO) and Food and Agricultural Organization(FAO) (Codex Alimentarius Commission, 2011).

Table1: Concentrations of Cu and Zn in snacks obtained from the two institutions

Snacks	Trace/toxic metal concentrations (mg/kg) in snacks							
	First Institution				Second Institution			
	Zn		Cu		Zn		Cu	
	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
Plt	0.25	2.15* ± 0.13	0.05	0.27* ± 0.03	1.00	1.77 ± 0.57	0.07	0.11 ± 0.04
Pota	1.32	1.79 ± 0.89	0.26	0.16 ± 0.14	1.02	2.45 ± 0.52	0.39	0.30 ± 0.20
Dnut	0.12	2.95* ± 0.60	0.09	0.42 ± 0.05	1.00	2.34 ± 0.50	0.38	0.26 ± 0.19
Bsct	0.44	2.73* ± 0.24	0.06	0.44* ± 0.03	0.61	2.62 ± 0.33	0.15	0.41 ± 0.08

Plt = Plantain chips; Pota = Potato chips; Dnut = Doughnut; Bsct = Biscuit

***Significantly high relative to values for other metals (p < 005).**

As presented in Table 2, the concentrations of Cd in snacks obtained from the two institutions were generally below or within the WHO/FAO recommended safe limits of 0.05 – 0.10 mg/kg. Potato chips obtained from the first institution and plantain chips obtained from the second institution had Pb concentrations of 1.19 ± 0.81 and1.23 ± 0.61 mg/kg respectively. These concentrations were marginally higher than the maximum range of 0.1 – 1.00 mg/kg prescribed by WHO/FAO (Codex Alimentarius Commission, 2011). Analysis of variance (ANOVA) indicated that there was no significant difference (P > 0.05) in metal levels in snacks obtained from different outlets in the two institutions (Table 3). Moreover, Independent-samples t-test analysis revealed that the differences between the mean metal levels in snacks obtained from the two institutions were not significant (P > 0.05).

Table 2: Concentrations of Pb and Cd in snacks obtained from the two institutions

Snacks	Trace/toxic metal concentrations (mg/kg) in snacks							
	First Institution				Second Institution			
	Pb		Cd		Pb		Cd	
	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
Plt	0.07	0.83 ± 0.04	0.06	0.10* ± 0.03	1.07	1.23 ± 0.61	0.10	0.08 ± 0.06
Pota	1.54	1.19* ± 0.81	0.03	0.05 ± 0.02	0.93	0.57 ± 0.47	0.04	0.06 ± 0.02
Dnut	0.15	0.32 ± 0.08	0.03	0.03 ± 0.02	1.50	1.19 ± 0.83	0.94	0.35 ± 0.54
Bsct	0.04	0.10 ± 0.02	0.01	0.02 ± 0.01	0.08	0.16 ± 0.04	0.04	0.03 ± 0.02

Plt = Plantain chips; Pota = Potato chips; Dnut = Doughnut; Bsct = Biscuit

***Significantly high (p < 005).**

Table 3: ANOVA table showing variation in metal levels in snacks obtained from different outlets

Source of variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.067	2	.034	.034	.967
Within Groups	44.477	45	.988		
Total	44.544	47			

Df = degree of freedom

It was observed that the concentrations of Zn, Cu, Pb and Cd were mostly within the upper limits of the range specified by WHO/FAO. However, the consumption of foods with such levels of metal concentrations over a long period of time may result in metal build-up in the body beyond tolerable limit. Though some metals, like Cu and Zn, are essential for proper biological functioning and as such may not constitute serious health concerns except when present at excessively high levels, many others have no known biological significance but are rather implicated in many health challenges including neurological disorder, liver, kidney and reproductive organ damage, cancer, respiratory tract diseases (Kurokawa*etal*., 1990; Duruibe*et al*., 2007, Adefris, 2011). Specifically, Cd is carcinogenic, and is known to have a tendency to accumulate in the kidney thereby causing renal dysfunction. Lead (Pb) is regarded as a classical chronic or cumulative poison, causing haematological, neurological, renal, cardiovascular, reproductive, and immune system disorders (Codex Alimentarius Commission, 2011). Even those metals that perform essential biological roles may become toxic when present in the body at intolerably high concentrations. Examples are the essential metals, Zn and Cu, used in this study. Codex Alimentarius Commission (2011) reports that Zinc is important for the formation and functioning of many enzymes, yet in animal studies, toxic doses of the metal has been found to cause weakness, anorexia, anaemia, diminished growth, loss of hair, morphological and enzymatic changes in the brain. Similarly, Cu is an essential nutrient, but high level of the metal in the body may cause symptoms of acute toxicity like nausea, abdominal discomfort, diarrhoea, hypotension, and even death (WHO, 2004; Codex Alimentarius Commission, 2011).

Some past studies such as Lanre-Iyanda (2011); Magomya *et al*. (2013); Oyegunle *et al*. (2014) have found low to moderate concentrations of metals in commonly consumed food samples including bread. The present findings call for concern in view of the fact that the study was conducted within tertiary institutions where food safety compromise is least expected. All the sampled snacks except biscuits are products of the informal home-made food business. In most cases, the vendors of these foods do not even prepare the foods by themselves, but are supplied by third party mobile food vendors and suppliers. The World Health Organization notes that the major health threat facing the public comes from raw and undercooked food, infected food handlers and inadequate hygiene measures in processing and storing such foods (WHO, 2015). Since the contaminants in focus in this study are metals, their entry points into the snacks are likely to be the raw materials and compromised processing. Adulteration is strongly suspected for the simple reason that the production environment of these snacks is usually as

good as not traceable.

The highest metal loads were found in biscuit and doughnut samples. These two snacks are made from refined wheat flour. The two snack samples might have been contaminated from two major sources (1) during cultivation of the primary raw material, wheat, and (2) during the processing of wheat flour into the final food products (biscuits and doughnut). It therefore implies that tackling the problem of food contamination requires a holistic approach. Concerted efforts should be directed at reducing the spate of soil pollution since the soil is a primary contamination source. Governments and stakeholders at all levels should map out adequate soil pollution control and management strategies to ensure that cultivation of crops is carried out on pollutants-free soil. Effective farming policies should be put in place to ensure soil sampling and soil tests are carried out on any plot of land to be used for farming; this should be done before and during planting seasons. Organic pesticides, rather than the conventional chemical pesticides, should be encouraged as pre- and post-harvest soil and crop treatments. Processing of crops and farm produce for consumption should be done in a way that would not further introduce contaminants into the food. Efforts should be made to capture the informal food and catering service operators in the regulatory plans and actions of the government. This will go a long way in improving the quality of foods that get to the consumers through their supply chains.

The findings of this study may be a reflection of what happens in other educational institutions in the country. The authorities of tertiary institutions and other levels of education in Nigeria are called upon to strengthen and widen their internal control mechanisms to guarantee the quality of foods sold to students and other people on their campuses.

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