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ORIGINAL RESEARCH

Heavy Metal Assessment of Unripe Plantain Flour Sold in Some Markets in Osun State, Nigeria

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ABSTRACT
Heavy metals, such as cadmium, arsenic and lead, are important environmental pollutants, particularly in areas with high anthropogenic pressure. Their presence in the atmosphere, soil and water, even in traces can cause serious problems to all organisms, and heavy metal bioaccumulation in the food chain especially can be highly dangerous to human health. Heavy metals enter the human body mainly through two routes namely: inhalation and ingestion, ingestion being the main route of exposure to these elements in human population. Heavy metals intake by human populations through food chain has been reported in many countries. This research work evaluated the level of heavy metals in plantain flour displayed in open containers for sale in ten locations alongside two packaged brands in Osun State. Heavy metals in the 12 samples were determined using Atomic Absorption Spectrophotometer (AAS).The average concentration for each heavy metal in all the samples ranged between 0 – 120.23 mg/kg for arsenic, 0.50 – 4.51 mg/kg for cadmium and lead was not detected in any of the samples. These findings indicate that foods displayed in open containers in markets or road sides are contaminated by the polluted environments. Excessive consumption can increase the level of heavy metal contamination in the body which may affect the health of the consumers.

KEY WORDS: *Heavy metals, Plantain flour, Osun state, Bioaccumulation, Public health.*

INTRODUCTION

Heavy metal is any metal or metalloid of environmental concern; such as cadmium, copper, lead, chromium and mercury, they are important environmental pollutants, particularly in areas with high anthropogenic pressure. Heavy metal bioaccumulation in food chain can be highly dangerous to human health, these metals enter the human body mainly through two routes namely: inhalation and ingestion, and with ingestion being the main route of exposure to these elements in human population. Heavy metals intake by human populations through the food chain has been reported in many countries with this problem receiving increasing attention from the public as well as governmental agencies, particularly in developing countries (Islam *et al*., 2007).

Interestingly, both government and health professionals have recognized health benefits of unripe plantain in the prevention of diabetes leading to increase in its uptake by general population in the last decade (Odenigbo, 2012; WHO,2008) making the Food and Agriculture Organization (FAO) to show great interest in the nutritional value of unripe plantain. It has been reported that contamination of

diets/food through pathogenic microorganisms often occur through mishandling of foods/drinks i.e. palm wine (Akinrotoye, 2014); unripe plantain floor spread on bare floor (Fagbohun *et al*., 2010). Pathogenic microorganisms is not the only contaminants causing injury or diseases to man; also trace heavy metals also contaminate foods/drinks which could result from different sources such as drinking water, high ambient air concentrations, industrial waste, acidic rain breaking down soils and food chain (Garty *et al*., 1996; Okonkwo *et al*., 2004; WHO, 2000; WHO, 2002)

Contamination of the unripe plantain with heavy metals could pose potential health risk to humans because these heavy metals have the ability to "bio-accumulate". Bioaccumulation means an increase in the concentration of a chemical in a biological organism over time, compared to the chemical's concentration in the environment. Reports from previous research have shown that compounds accumulate in living things any time they are taken up and stored faster than they are broken (metabolized) or excreted (Garty *et al*., 1996).

Plantain is one of the most important crops of the tropical plants. It belongs to the family Musaceae and the genus Musa having a life span of about 15 years. The fruit average 125 kg by weight (Fagbohun *et al*., 2009) which is very rich in minerals and vitamins. Several food consumption surveys in Nigeria identified plantain among the major starchy staples (Odenigbo, 2012; Okeke *et al*., 2008; Ogechi *et al*., 2007). Mature unripe plantain can be made to chips and sundried to reduce the moisture content to a barest minimal; often discouraging the growth of spoilage organisms (Fayemi, 1999) and increases the shelf-life of the stored product.

In Nigeria, as well as other West African countries, the unripe plantain is traditionally processed into flour (Yarkwan and Uvir, 2015). The unripe plantains are harvested, peeled, sliced and sundried, then milled and ground to obtain flour. When processed into flour, it is used traditionally for the preparation of gruel, which is made by mixing the flour with appropriate quantity of boiling water to form a thick paste and is eaten with various sauces (Mepba *et al*., 2007).

To the best of our knowledge no study has been conducted in this environment (selected area in Osun state) to evaluate the concentration of heavy metals present in unripe plantain flour and the potential hazards such contamination may pose to human health. It is possible that these heavy metals could have access into unripe plantain flour during planting, harvesting, processing, packaging, storage or sale of the product (Grandjean, 1992; Fox, 1976). The presence of these toxic metals may appear harmless in minute quantities, however their accumulation over time carries potential health risk to human who regularly consume unripe plantain flour contaminated with toxic metals (Tulchinsky and Varavikova, 2009). Therefore, it has become imperative to assess the levels of heavy metals in unripe plantain flour sold in different markets in Ife and Ilesha Local Government of Osun State, Nigeria, this study was undertaken to investigate heavy metal in plantain flour from ten locations in Osun state alongside two packaged brands.

RESULTS

Table 1 shows the mean heavy metal content in the plantain flour samples. Lead was not detected in any of the samples, there was significant difference in the cadmium content of the samples; these values were within the range of 0.50mg/kg ± 0 for sample H to 4.51mg/kg ± 0.02 for sample F while only one sample contained arsenic; the value was 120.23mg/kg ± 0.01 for sample J. Branded plantain flour samples and the control sample had no heavy metal.

DISCUSSION

Lead was not detected in any of the samples. This does not necessarily mean that unripe plantain flour cannot be contaminated with lead. Cadmium was present in all the samples except for control sample, Bills instant plantain flour and LTJ4 Oye plantain flour (packaged brands). The presence of cadmium in the samples could be that the plantain up-took/bio-accumulated cadmium from cadmium contaminated soil during planting (Idodo-Umeh and Ogbeibu, 2010).

The presence of cadmium in those samples could also be as a result of unhygienic practices of the processor; as some of them dried the sliced plantain on net spread on the soil. According to Kocbach *et al*. (2006) Cadmium can be released from vehicle emissions. Cadmium could have been absorbed by the samples during display in open containers to attract buyers in the market and at road sides; as cars passing could release cadmium. Cadmium been detected in

Table 1: Mean Heavy metal content of Plantain flour samples from various locations in mg/kg

Location	Samples	Lead	Cadmium	Arsenic
Atakumosa, Ilesha	A	ND	0.53 ± 0.06^{b}	ND
Iloro, Ile-Ife	B	ND	0.51 ± 0.01^{b}	ND
Akogun arubidi, Ile-ife	C	ND	2.00 ± 0^{e}	ND
Ilode Ajefowobaje, Ile-ife	D	ND	0.60 ± 0.17^{b}	ND
Gbongan, Gbongan	E	ND	1.50 ± 0^{d}	ND
Itakogun, Ile-ife	F	ND	4.51 ± 0.02^{g}	ND
Erin-oke Ijesha, Ijesha	G	ND	1.07 ± 0.12^{c}	ND
Modakeke olorunsogo, Modakeke	H	ND	0.50 ± 0^{b}	ND
Oja-tuntun, Ile-ife	I	ND	1.00 ± 0^{c}	ND
Sabo-irojo, Ilesha	J	ND	3.03 ± 0.06^{f}	120.23 ± 0.01^{b}
Bills instant plantain flour	Y	ND	ND	ND
LTJ4 Oye plantain flour	Z	ND	ND	ND
Control	U	ND	ND	ND

Key: U is control sample, ND = detected. Values with different superscripts are significantly different ($p < 0.05$)

the plantain flour samples in various concentrations is of public health importance and cadmium when ingested by humans; it accumulates in the intestine, liver and kidney (Malviya and Wagela, 2001).

The health effects of chronic exposure of Cadmium include proximal tubular disease and osteomalacia. Long term exposure to cadmium is associated with renal dysfunction. Cadmium is biopersistent and once absorbed remains resident for many years. High exposure can lead to obstructive lung diseases and has been linked to lung cancer. Cadmium may also cause bone defects in humans and animals. The average daily intake for humans is estimated as 0.15 mg/L from air and 1µg from water (Jarep *et al*., 1998). Maximum limit of 0.2 mg/L Cd in plant and 5.0 mg/L Pb in plant was prescribed by WHO/FAO (2007). The values for the standard compared to our work indicate Cadmium (Cd) contamination of plantain flour.

Arsenic was present in one of the samples and it was found in high concentration. This could be as a result of the plantain been cultivated in area being irrigated with arsenic contaminated water. According to FAO/WHO (2010) arsenic could be released into the environment as result of dissolution of minerals (particularly into groundwater), exudates from vegetation and wind-blown dusts; dissolution of minerals (particularly into groundwater), agricultural pesticide production and use. The sample could have absorbed arsenic via any of these routes; since most processors lack basic food safety practices.

CONCLUSION

This study has revealed high concentration of the Arsenic and cadmium in some of the samples. Cadmium exposures are associated with kidney and bone damage. Cadmium has also been identified as a potential human carcinogen,

causing lung cancer. These findings are indicative of environmental pollution due to industrial and vehicular emissions and also the mode of handing during preparation of the plantain flour.

RECOMMENDATION

Plantain flour is a commodity with economic, religious, social and cultural value and hence should be maintained in its original unadulterated form. To avoid heavy metals poisoning and high heavy metal intake, we advocate consumption of control or branded unripe plantain flour. Processors of plantain chips and flour should be educated on quality food processing and food safety. Inspection of processing units by responsible government agencies will ensure that best practices are complied with and consumers will have access to safer plantain chips and flour

MATERIALS AND METHODS

Study Area

Various markets and location especially along the Highways were visited across the Local government and a total of ten (10) samples of plantain flour (n = 10) were obtained from different sellers located in various parts of Osun state, Nigeria. The market areas include Atakumosa, Ilesha, Iloro, Ile-Ife, Akogun arubidi, Ile-ife, Ilode Ajefowobaje, Ile-ife, Gbongan Major Market, Gbongan, Itakogun, Ile-ife, Erin-oke Ijesha, Ijesha, Modakeke olorunsogo, Modakeke, Oja-tuntun, Ile-ife, Sabo-irojo, Ilesha.

Sample Collection and Preparation

Plantain flour samples were procured from 10 markets in Osun state, Nigeria. Packaged plantain flours (branded) namely Bills instant plantain flour and LTJ4 Oye plantain flour were procured from local processors. Unripe Plantain fruits were also purchased to produce plantain flour in the laboratory which served as control. The result was analyzed using statistical package for social science (SPSS) version 17.0. Results are presented as means ± standard deviation.

Heavy metal analysis

All the samples were oven-dried at 70–80°C for 24 h, to remove all moisture. 1.0 g of different plantain flour samples was weighed into a digestion tube and 10ml of 98% nitric acid was added. This was then placed in a water bath and allowed to boil for about 72 hours. The resulting pale yellow solution was made up to 25ml with de-ionized water for each sample and stored. The solutions were analyzed for Lead (Pb), Cadmium (Cd) using buck 200 Atomic absorption spectrophotometer (AAS). A certified standard reference material was used to ensure accuracy and the analytical values were within the range of certified value; The analytical methods adopted by the AOAC (Association of Official Analytical Chemists) are used by government agencies concerned with the analysis of fertilizers, foods, feeds, pesticides, drugs, cosmetics, hazardous substances, and other materials related to agriculture, health and welfare, and the environment (AOAC, 2005).

Determination of arsenic

20 ml of extracted sample solution was put in a 250 ml conical flask. 10 ml of distilled water was added . 1 g of sodium bicarbonate crystals was added. 1 ml of 1 % starch solution was added. It was shook clearly until crystals are dissolved. It was titrated slowly with 0.02N iodine solution until a permanent blue color solution is formed which is the end point

Calculation; = T x 31 x 50 / 20 x 2 (AOAC, 2005)

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