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Analysis of some heavy metals (Pb, Cd, Cr, Fe , Zn) in processed cassava flour (garri) sold along the road side of a busy highway

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ABSTRACT

The level of some heavy metals: Lead, Cadmium, Chromium, Iron, and Zinc (Pb, Cd, Cr, Fe & Zn) in "garri" sold along a busy road was investigated. Station road, within Port Harcourt metropolis, was chosen as sampling point. For comparison purpose, garri sample protected from the prevailing environmental conditions was also analyzed for the above metals. AAES procedure according to ASTM (2000) standard methods was used. Results obtained were compared with FAO / WHO (2001) dietary allowance for trace metals in foods. Accumulation factor (AF) of each of the metals was calculated by a ratio of the values of the concentration of metals in the test samples and reference values. The garri samples were slightly contaminated by Pb (0.13), excessively polluted by Cd (26.0) and Cr (93.0) and slightly polluted by Zn(1.31) and Fe (1.65). The presence of the heavy metals in the unexposed garri could be traceable to the soil. The elevated levels of the metals in the exposed garri, could however be attributed to deposition from the prevalent environment laden with metallic pollutants from automobile exhaust emissions, industrial and commercial activities.

Key words: Cadmium (Cd), Chromium (Cr), Iron (Fe), Lead (Pb), Processed Cassava flour (garri), Zinc (Zn).

INTRODUCTION

Environmental pollution has become a global problem today. Man in bid to improve his wellbeing on earth has developed technologies in aviation, maritime, agriculture, medicine, information, metallurgy etc. Each of these technologies has set goals to achieve excellence. This has led to massive industrialization and urbanization. Heavy loads of pollutants are constantly being introduced into the air (atmosphere), soil (land) and water including ground water. This trend has led to environmental pollution [1]. Worldwide, millions of people suffer environmental pollution related health problems. Several studies have been conducted on pollution of soils, surface and ground water and the atmosphere [2,3,4,5,6]. Chief amongst these pollutants are heavy metals. Although heavy metals are naturally present in soil, contamination or pollution comes from different sources, and among them, heavy traffic is an important source in most of the roadside soils [7]. Road sediments are a complex environmental media. Their composition reflect inputs from a variety of sources including water transported material from surrounding soils and slopes, dry and wet atmospheric deposition, biological inputs, road surface wear, road paint degradation, vehicle wear (tires, body, brake linings, etc.), vehicle fluid and particulate emissions, and inputs from the wear of sidewalks and buildings [8].

Studies have also shown that roadside soils become enriched with Pb and some other heavy metals emanating from vehicle emission [9]. Nigeria crude oil is known to have about 0.003 – 42.31mg/kg of transition metals such as V, Cr, Mn, Fe, Co, Ni and Cu [10]. During the crude refining processes some of these metals may not be completely removed and can therefore be emitted via automobile exhaust. Heavy metals have been reported on vegetables grown near busy traffic highway [11]. Contaminated roadside soils may constitute a health hazard if the metals are transferred to other reservoir [12] Studies on roadside soils in the Manoa Basin of Honolulu Hawaii, have shown that Cu, Pb and Zn have significant anthropogenic enrichments [12].

The article (garri), a staple food in most parts of Nigeria, is usually openly displayed along road sides including busy highways for buyers. This exposes it to automobile exhaust emissions and atmospheric dusts. This work was therefore carried out to ascertain any possibility of metallic deposition on the exposed food.

Fig. 1: Display of Garri along a busy roadside

Fig. 2: Roadside Garri

MATERIALS AND METHODS

The ASTM [13] method was used to determine the heavy metals in the sample. 5g of the garri sample was accurately weighed and transferred into 100ml beaker followed by 2M H_2SO_4 and HNO_3.The mixture was digested on a heating mantle for 2 hrs, and allowed to cool. 50ml of distilled/deionized water was added and filtered; the resultant filtrate was used for trace metals assay using the Buchman Atomic Absorption/Emission Spectrophotometer (AAES).

RESULTS AND DISCUSSION

Table 1: Trace Metals in Processed Cassava Flour (Garri). Values are means and standard deviation of 5 measurements

S/N	Metals	Exposed Garri (mg/kg)	Unexposed Garri (mg/kg)	FAO/WHO Tolerable Limits	Accumulation Factor (AF)
1	Pb	0.04±0.00	0.01±0.00	0.30mg/day	0.13
2	Cd	0.04±0.00	0.01±0.00	1.50µg/day	26.0
3	Cr	0.14± 0.01	0.01±0.00	1.50µg/day	93.0
4	Fe	39.80±0.06	24.10±0.04	15mg/day	1.65
5	Zn	31.00±0.14	23.50±0.20	10-15mg/day	1.31

Table 2: Significant Intervals of Contamination/Pollution (C/P) Index (or AF) values

C/P	Significance
< 0.1	Very slight contamination
0.10 – 0.25	Slight contamination
0.26 – 0.50	Moderate contamination
0.51 – 0.75	Severe contamination
0.76 – 1.00	Very severe contamination
1.10 – 2.00	Slight pollution
2.10 – 4.00	Moderate pollution
4.10 – 8.00	Severe pollution
8.10 – 16.00	Very severe pollution
>16.00	Excessive pollution

Source: [14]

As contained in table 1, the trace metals under study were detected at differing concentrations. The amounts of Iron (24.1 ± 0.04 mg/Kg and 39.8 ± 0.06 mg/Kg) and zinc (23.5 ± 0.20 mg/Kg and 1.0 ± 0.14 mg/Kg) respectively in the exposed and unexposed garri samples were higher than the recommended daily allowance of 15mg Fe/day and 10-15mg Zn/day respectively. Similarly, Cadmium (0.01 ±0.00 mg/Kg, 0.04 ±0.00) and Chromium (0.01 ±0.00 mg/Kg, 0.14 ±0.01) exceeded the recommended daily allowance of 1.5µg Cd/day and 1.5µg Cr/day. However, the concentration of Lead in the exposed (0.04± 00 mg/Kg) and unexposed (0.01±0.00 mg/Kg) garri samples were below the recommended daily allowance of 0.3mg Pb/day. It is worthy of note that the AF of all the metals with the exception of lead exceeded unity. AF lower than unity indicates a contamination range, while greater than unity indicates a pollution range as shown in table 2 [14]. The garri samples were excessively polluted by Cd (26) and Cr (93) and slightly polluted by zinc (1.31) and iron (1.65).

Heavy metals are natural components of the earth's crust. They are stable and persistent in environmental pollutions and contaminations. They include any metal that has a density of 3.5g/cm^3 and above. Heavy metals include essential elements like iron, zinc, copper, etc. as well as toxic metals like Lead, Cadmium, Chromium, Mercury, etc. The essential elements are sometimes called trace elements or micro nutrients because they are essential to plant growth at very low concentrations. In humans, their vital to everything from normal bone growth to component of the smallest enzymes involved in the minutest physiological process [15]. An insufficient supply of an essential elements will cause deficiency diseases. Zinc ease in normal growth and tissue respiration and also play an important role in the development of normal coat of hair. Zinc and copper in addition to calcium play important roles in bone development [16]. Iron, manganese, zinc and copper in their ionic states are bound to carrier proteins embedded in the intestinal lining. Iron the blood-building element is essential in the formation of hemoglobin, in oxygen transfer and in all cellular respiration. Copper together with iron also form integral parts of bio-catalyst [17]. They also reaffirmed that chromium when acting with insulin is required for glucose uptake. A deficiency could produce diabetes-like condition. However, whether a metal is essential or not, exposure above a certain level may cause adverse effects [18]. Heavy metals are not easily biodegradable leading to their bioaccumulation in human vital organs. This might result in varying degree of illnesses on acute or chronic exposures [19].

Human beings have been poisoned by Lead bearing dust brought home on cloths of workers [20]. According to Environmental Protection Agency [21], some heavy metals Lead inclusive cause low intelligent quotients in young children under the ages of 6-12 years who lived near their contaminated residents. Also, low level exposure to lead is known to cause behavioural problems, attention deficient disorders, impaired hearing and kidney damage. At high exposure, it could result in fertility problems, nervous disorders, muscles and joint pains as well as increase in blood pressure. Lead has been implicated with abnormal movement and reflexes, peripheral neurological effects, peripheral neuropathy, inhibition of biosynthesis of haem, slight anemia and ulcers [22].

The presence of Cadmium (Cd) at an elevated level in human body causes renal system failure such as tubular and glomerula damage, proteinura tubular nephrosis (inflammation of the kidneys) tubular dysfunction, inhibition of biosynthesis of haem, slight anemia, respiratory tract malfunction, Ostemalacia (bone malformation, tooth caries, heart diseases, prostate gland and lung cancers, and chromosomal aberrations [22]. The presence of heavy metals in the unexposed garri samples may have their origin from the soil [23,24,25,26]. Iyaka and Kakulu [27], carried out a research work on heavy metal concentrations in top soils around ceramic and pharmaceutical indusrial sites in Niger State, Nigeria. Lead, copper, nickel and zinc contents in agricultural soils within the vicinity of the industries were determined using the AAS technique. The values obtained were higher than the background level measured in control soil sample.

However, the study revealed an elevated concentration of the trace metals in the exposed garri in comparison with the unexposed garri sample. This could have arisen from the unhygienic practices including atmospheric exposures of the food article by food vendors. The city of Port Harcourt is associated with heavy industrial and commercial activities. Road side sediments as well as automobile exhaust emissions are the most likely routes of these heavy metals' presence in the food.

CONCLUSION

Elements such as nickel, zinc, iron, copper and magnesium etc. are essential because they are associated with enzyme systems and other biochemical processes in the body [28]. Interest in these metals which are required for metabolic activities in the organism lies in the narrow "window" between their essentiality and toxicity. Inspite of their benefits, some trace elements cannot be regarded as essential to life. Lead, cadmium, arsenic, and mercury are toxic at very low concentrations and are termed non – essential. However, whether essential or not, when bioaccumulated, once they exceed the total body burden, disease conditions may arise. The recommended daily intake of iron is 10-20mg; for zinc, it is 3-5mg for children, and 10 – 15mg for adults; chromium, 0.01-0.08mg for infants and children and 0.05 – 0.2mg for adults [29]. It is therefore pertinent to educate both vendors and consumers on the need for proper handling of food in the face of our polluted environment.

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