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ORIGINAL ARTICLE

Level of Occurrence of Lead in Finger Millet in Niger State Metropolis

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Abstract

Background: *Eleusine coracana*, a grain crop that may reach a height of 170 cm, is frequently referred to as a cereal food. It is a member of the *Poaceae* genus of plants. Due to its extreme toxicity at very low quantities, lead (Pb) is one of the most significant trace heavy metals to be examined.
Aim: The main objective of this study was to determine the prevalence of lead in finger millet in the capital city of the Niger State.
Methods: The lead metal was determined by flame atomic absorption spectrometry (FAAS) following a pressurized microwave-assisted wet digestion and the use of muffle furnace on the processed/certified finger millet samples with a combination of nitric acid, sulfuric acid, and perchloric acid (4:1:2). Based on calibration with a fortified analytical solution, the measurements were made (lead chloride).
Results: With the exception of Suleja millet, which recorded a range of 0.01-1.55 mg/L, the concentration of lead in finger millet samples evaluated in all Local Governments was found to be over the WHO recommended level of acceptable lead in cereals (0.01-0.05 mg/L). The LG (0.170.08 mg/L at range of 0.09-0.32 mg/L) and Kontagora Local Government (1.570.24 mg/L at range of 1.19-1.93 mg/L) had the highest and lowest amounts, respectively. Average lead values in different types of finger millet collected from diverse LGs were statistically different from one another ($p<0.05$).
Conclusion: The primary source of Pb in finger millet grain in various depositional locations is atmospheric deposition. The majority of the lead in millet roots comes from the soil and lead contribution rates from the soil to the millet roots in high deposition locations would be much higher than those in low deposition areas.

Keywords: Lead, Eleusine Coracana, Finger Millet

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INTRODUCTION

Lead is one of the most important trace heavy metals due to its serious toxicity even at very low concentrations. When lead levels in the body exceed what is considered tolerable, it might be harmful right once or cause long-term health problems [1]. It has the potential to harm the neurological system (particularly in young children) as well as induce blood and brain issues [2]. Industrial pollutants, soils, and contaminated foods are all major causes of lead exposure [3]. The Joint FAO/WHO Expert Committee on Food Additives (JECFA) set a Provisional Tolerable Weekly Intake (PTW I) for Pb of 0.025 mg/kg body weight, or 0.20–0.25 mg/day for people [4]. Lead (Pb) has no known biological relevance, but it does produce reactive oxygen species (ROS) when it interacts with plants [5]. Pb has become a major environmental contaminant as a result of fast industrialization and human activities involving Pb, such as mining and smelting [6]. Pb can enter the food chain through crops in two ways: through root absorption from the soil and through foliar absorption from the atmosphere [7]. Because Pb poses a health concern to humans, avoiding Pb contamination in millet grains is critical for food safety. For millet, it is especially critical to precisely verify Pb pollution sources and understand its pollution processes [8]. It would be feasible to determine dangers related with Pb pollution by assessing the contribution rate of various pollution sources to Pb contamination in millet grains [9].

Eleusine coracana (finger millet) is a cereal grass that is primarily produced for its grain. It is a tough, tillering annual grass that grows up to 170 cm tall [19, 11, 12]. The panicle inflorescence has 4-19 finger-like spikes that, when mature, resembles a fist, hence the name finger millet is picked up for it [12]. Up to 70 alternate spikelets, each containing four to seven tiny seeds that can be seen on the spikes [13]. The pericarp of the seed is separate from the kernel and can be easily detached from the seed coat. In comparison to other parts of the world, finger millet is a staple food in many Southern Asian and African countries, where it is one of the most widely farmed crops. It can be preserved for a longer

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period of time than most grains, making it a suitable famine crop [11]. The grain is very nutritious, easily digestible, and versatile, as it can be cooked, processed into porridge flour, or used to make cakes [10]. Infants and the elderly should consume sprouted grains. Finger millet is also used to manufacture liquor and beer, with byproducts that can be fed to cattle. Atomic absorption spectrometry is used to evaluate food samples after the digestion has turned them into solutions. There is always a chance of analyte loss and contamination during sample digestion. [1]. Direct entry of solid samples into the graphite furnace, on the other hand, has several advantages, including high detection power, fast analysis, low danger of contamination and loss of the analyte (s), and the absence of hazardous and/or corrosive reagents [14].

A high-intensity xenon short-arc lamp, an extremely high-resolution double monochromator, and a charge-coupled device (CCD) array detector are all part of the newly designed high resolution continuum source atomic absorption spectrophotometers (HR-CSAAS). Within a wavelength range of 0.3–1.0 nm, the spectral environment of the analytical 'line' can be viewed. The HR-CS-AAS approach has been demonstrated to be a reliable and accurate method [15]. Improved signal and baseline stability, as well as effective correction of even complicated, high, and highly rapid changing continuous and discontinuous spectrum interferences, are the key benefits of HR-CS-AAS [16].

MATERIALS

Collection of Samples

The selected finger millet samples were collected on April 10th, 2021 from Mariga, Magama, Borgu, Bosso, Suleja, Tafa and Wushihi Local Government Area, Niger State, Minna, Nigeria in different storage, farms and markets.

Authentication of Samples

The selected finger millet samples were authenticated after few days of collection and it was approved for research use at the Department of Plant Biology, FUTMINNA.

Reagent and Chemicals

Nitric acid, sulfuric acid, perchloric acid, distilled/de- ionized water, oxochloric acid, hydrochloric acid, and sodium chloride salt etc. All the listed chemicals are of analytical grades.

METHODS

Sample Preparation

The region was chosen based on the fact that millet farmers, producers, and sellers make up a significant portion of the local workforce. Nine local government areas in all, 45 samples (5 each), were gathered. As some farmers declined to cooperate and others did not have millet at the time the sample collection was done, the samples were obtained in a convenient manner. They were either too young or dried. Each millet sample was put into a 100ml HDPE bottle after being soaked in 20 percent HNO3 for 24 hours and then rinsed with de-ionized water. The obtained samples were ground in an electric blender before being labeled, sealed, and kept in the refrigerator at a temperature of no more than 5°C [17,24].

Sample Digestion

According to [24], [28], and [29], the finger millet samples were prepared using the wet digestion process and examined using Atomic Absorption Spectrometry. To get rid of sticking particles, 2 grams of each sample was precisely washed three times with distilled water. In order to get the moisture out, this was oven dried at 100°C. Using a mortar and pestle, it was ground. The dried sample was heated to 550°C in a muffle furnace for 4 hours, at which point it was reduced to ash. It was placed in a desiccator to chill and keep out moisture, and then 5ml of prepared 10% nitric acid and perchloric acid were added, along with a tablet of selenium catalyst. The tube was inserted into a digestion block, where it was progressively filtered and digested. Filtered mixture was then added to a 50ml volumetric flask and filled to the top with distilled water. It was brought to the lab for an atomic absorption spectrometry heavy metal analysis. As with the grass sample, 2 grammes of the millet sample were consumed. Following that, it was brought to the lab for atomic absorption spectrometry [18,24].

Preparation of Standard

A serial dilution method was used to prepare the working standards and the concentration of the metals (i.e. As, Pb, Cr, Cd, and Cu etc) in each sample digest were determined using Atomic Absorption Spectrophotometer equipped with a digital readout system [19]. Therefore, initially, 10 g of lead chloride was dissolved in 1000 ml volumetric flask. Then from already prepared 1000 ppm, 10 ml was removed to make it up to 100 ppm in volumetric flask. However, standard solution at varying concentration (0.5, 1.0, 1.5, 2.0 and 2.5 ppm) was equally produced for the analysis.

Data Analysis

Data obtained were analyzed using SPSS and Microsoft Excel and results were expressed as mean ± standard deviation. One way analysis of variance (ANOVA) was carried out as $p<0.05$ considered statistically significant. Duncan's multiple range test (DMRT) was used to compare mean values of test groups and controls as well as differences within group mean of the various test groups.

RESULTS

Compositions of lead in Finger Millet from Different Local Government

Table 1 below shows the concentration of lead in finger millet from some selected Local Government Areas in Niger State, Minna. The values recorded shows significant difference ($p<0.05$) between the standard and the samples.

Lead Composition in Finger Millet from Some Areas in Niger State

Figure 1 below shows the concentration of lead in finger millet from Suleja, Bosso, Kotongora and standard. The concentrations are very small compared to the standard and highest concentration is recorded in samples collected from Kotongora.

Table 1. Lead Composition in Finger Millet from Some Selected LG

LocalGovernment	Concentrations (mg/L)	Range
Mrg	1.11 ± 0.75^{cd}	0.03-1.84
Mgm	0.81 ± 0.52^{bc}	0.09-1.59
Bosso	1.05 ± 0.12^{bc}	1.00-1.32
Knt	1.57 ± 0.24^{d}	1.19-1.93
Wsh	1.24 ± 0.36^{cd}	1.00-1.86
Brg	1.01 ± 0.37^{bc}	0.54-1.57
Suleja	0.61 ± 0.67^{ab}	0.01-1.55
Taf4	0.60 ± 0.28^{ab}	0.19-0.93
Kch	0.17 ± 0.08^{a}	0.09-0.32

Values are Mean±Standard Deviation of determination of three replicates. Superscripts with different values on same column are p<0.05 (significantly different)

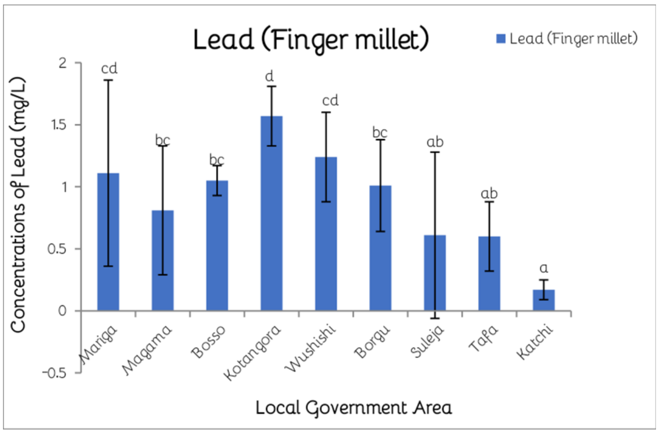

Figure 1. Lead Compositions in Finger Millet from Some Selected Areas in Niger State

DISCUSSION

The level of occurrence of lead in finger millet from different LGA in Niger State metropolis is shown in Table 1 The result showed the highest concentration (1.57±0.24a mg/L) in samples obtained from Kontagora, while the lowest concentration (0.17±0.08a mg/L) was recorded in Katcha. Furthermore, the highest concentrations might be due to erosion while farming, lack of freshwater for cropping, environmental deposition, and probably use of contaminated tools for farming. In Magama, Borguand Bosso, the range of lead concentration was 0.09-1.59, 0.54-1.57, and 1.00-1.32 mg/L, respectively. This is above the standard limit of lead in grains as described by FAO/WHO (0.05-0.15 mg/L). This is in line with the results obtained by Gunduz et al.'s study, which recorded 0.47±0.08 mg/kg lead concentrations in rice at a p-value of 0.242 [20]. It also stands in stark contrast to the study of Tassew Belete et al. [25] that was conducted in Ethiopia and claimed that lead and cadmium were not present. High lead concentration in milk may have been caused, in part, by the high lead concentration in the drinking water. The average limit of detection values of different LGA for the determination of lead in rice by AAS was found to be 1.19-1.93 mg/L which was found in finger millet analyzed in Kontagora. And this value was the triplicate of each sample obtained.

From the samples analyzed in this study, there was a significant difference (p<0.05) among some of the finger millet analyzed in some LGA. Therefore, in Bosoo, Magama and Borgu LGA, there was no significant difference (p>0.05) in lead concentration with values of 1.05±0.12bc, 0.81±0.52bc, and 1.01±0.37bc mg/L. This is consistent with the work of Atilgan et al., 2012, in which lead concentrations of some selected grains were analyzed with no significant difference (p>0.05) among all but above the standard limit set by FAO/WHO [20]. Lead compositions from the samples obtained in Suleja and Tafa showed no significant difference (p>0.05) i.e. 0.61±0.67ab and 0.60±0.28ab mg/L respectively. However, Suleja recorded the lowest concentrations which satisfied the acceptable limit (0.01-0.15 mg/L) as seen from the range (0.01-1.55 mg/L). Therefore, it can be deduced from this study that, among all the LGA, finger millet could be attributed to be the safest for consumption. This is similar to the work of Ashraf et al., who reported a safe concentration of lead (0.01-0.02mg/L) in *Oriza sativa specie* [21]. According to Miranda et al. [26], significant amounts of Cd and Pb can be transferred from polluted soil to plants and grass, causing accumulation over time of these potentially toxic metals in grazing ruminants, particularly in cattle. They also noted that significant amounts of Cd and Pb can be transferred from polluted soil to plants and grass.

Soil is the ultimate deposition of atmospheric deposition, and atmospheric deposition has become one of the important input pathways for soil Pb. It was found that atmospheric deposition is the main source of finger millet Pb in the case of low soil and depletion of lead contents. Pb concentration in soil and atmospheric deposition in the high deposition are aware not only higher in content but also higher in biological activity, therefore having higher environmental and ecological risks [22] as it is easier to transfer Pb from soil to plants. The reason for higher lead concentrations in millet may be due to industrial and agricultural activities and air pollution [23]. When it comes to potentially harmful impacts on human health, Cd and Pb are two of the components that have raised the greatest concerns. The findings of this study concur with Jeng, et al. [27] in that monitoring the content of Cd and Pb in cow milk is necessary to protect consumer health.

CONCLUSION

Lead standard concentration as seen in this study is significantly higher than that of regional finger millet analyzed. Atmospheric deposition was the main source of lead in most of grain crops. The results from this study indicate that reducing the influence of atmospheric deposition of finger millet may be more important to control the lead pollution of millet than controlling the lead pollution of soil.

Recommendation

Based on this study, it is recommended that future scholars run more research on other parts of finger millet plant to ascertain the level of the lead. Moreover, lead determination in soil, water, and other materials used in finger millet cropping is encouraged to be screened to ensure the environment is free from lead toxicity.

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