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Estimation Of The Level Of Polycyclic Aromatic Hydrocarbons And Heavy Metal In Maize Grown In Bayelsa State Nigeria.

Olubunmi Olusoga Ezomoh; Sanusi Raliatv Abike,
Oguzie Delight Amarachi.
Department Of Biochemistry, Faculty Of Basic Medical Sciences, Niger Delta University.

Abstract
The purpose of the study was to quantify the concentrations of heavy metals and polycyclic aromatic hydrocarbons (PAHs) in maize from Bayelsa State. The study's conclusions provided important information about the pollutant contamination of maize. The investigation revealed the presence of various polycyclic aromatic hydrocarbon (PAH) components in the maize samples. Due to the possible health hazards associated with PAHs, which are chemical molecules that might develop during incomplete combustion processes, it is important to be aware of their presence in food products. The study found that the levels of PAHs in maize from Bayelsa State are at the acceptable limits set by regulatory bodies. This indicates safety to human health. This research analyzed 7 heavy metals such, cadmium, zin, Magnesium, Lead, iron and nickel. The findings indicated that magnesium has the concentration range of 8.104 to 12.024ppm, cadmium contains 0.013 to 0.018ppm, iron content is 1.31 to 1.91, nickel content is 0.027 to 0.030ppm, sodium content is 3.76 to 4.17ppm, lead content is 0.010 to 0.013, zinc ranges from 0.23 to 0.356, copper content ranges from 0.128 to 0.136ppm. The result indicated that maize has less range of heavy metals as recommended by world health organization, therefore, maize grown in Bayelsa State are safe to the human health.

Keywords: *Heavy metals, Polycyclic aromatic hydrocarbons (PAHs), Maize, Pollutant, Human health.*

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I. Introduction

Concern about mineral soil pollution has significantly increased as a result of global social and economic growth (Zhao *et al*., 2015; Yang *et al*., 2018). Increased mineral concentrations in soils are the result of mineral discharge into the environment brought on by a number of human activities, such as mining and smelting, the annihilation of electrical waste, and agricultural practices. Toxic chemicals can accumulate in plant tissues, causing them to lose their nutritional value, become unfit for consumption, or even endanger human health. This is a major concern for both the food industry and the general public due to the diseases connected to consuming foods contaminated with heavy metals and being exposed to contaminated settings.

Uncompleted combustion of organic materials results in the formation of a class of organic chemicals known as PAHs. Air pollution, tobacco smoke, and grilled or smoked food are just a few of the places they can be found. On the other hand, when consumed in significant numbers, heavy metals are naturally occurring substances that are hazardous to people. According to Perera *et al*., (2015), they can be found in a variety of places, such as pesticides, fertilizers, and industrial waste. The health effects of individual PAH chemicals vary (Abdel-Shafy and Mansour, 2016; Rengarajan *et al*., 2015). Research by Burchiel and Gao (2014) demonstrates that numerous PAHs exhibit multiple toxicological effects, including immunotoxicity, teratogenicity, mutagenicity and carcinogenicity across various organisms. These compounds show particular ecotoxicological impacts on avian species and aquatic ecosystems, affecting both vertebrate and invertebrate populations. (Abdel-Shafy and Mansour, 2016). The degree of adverse health effects from PAH exposure depends primarily on three critical parameters: the route of exposure (inhalation, dermal, or ingestion), the temporal duration of exposure (acute vs. chronic) and the concentration or dose received by the organism (Tong *et al*. 2018; Rajpara *et al*., 2017)

Heavy metals, defined as naturally occurring elements with high atomic masses and densities exceeding five times that of water, exert multifaceted toxic effects on biological systems. These elements disrupt cellular organelles including membranes, lysosomes, endoplasmic reticulum, mitochondria and nuclei, while interfering with critical metabolic, detoxification, and repair enzymes. Their ions directly interact with DNA and nuclear proteins, inducing structural damage and conformational changes that alter cell cycle progression, promote carcinogenesis, or trigger apoptosis. Laboratory investigations confirm that metals such as arsenic, cadmium, chromium, lead, and mercury primarily mediate toxicity through reactive oxygen species (ROS) generation and subsequent oxidative stress pathways

II. Materials And Method

Sample Collecion

Sample Area

The sampling site for this study was strategically selected at Niger Delta University located in Amassoma, Bayelsa State, Nigeria.

Sample collection

This study utilized yellow maize and white maize varieties obtained from Niger Delta University's agricultural fields in Amassoma, Bayelsa State, Nigeria.

Reagent

The reagents includes deionized water (H_2O), dichloromethane (CH_2Cl_2), ethyl chloroformate ($C_3H_5ClO_2$), sodium carbonate (Na_2CO_3) standards, petroleum ether, and concentrated nitric acid (HNO_3, 65%). All chemicals were of analytical grade purity.

PAHs Sample Analysis

The quantitative analysis of polycyclic aromatic hydrocarbons (PAHs) in the samples was performed using gas chromatography (GC) with flame ionization detection.

Gas Chromatography Analysis

Gas chromatography serves as an effective analytical technique for separating and identifying volatile, thermally stable non-polar compounds. The method is equally applicable for examining semi-volatile substances such as polycyclic aromatic hydrocarbons (PAHs).

Chromatographic condition

GC	Hp 6890 powered with HP Chemstation Rev. A09.1
Column:	HP-1
Column length	30m
Column ID	0.25m
Injection Temperature	250C
Detector Temperature	20C
Detector	FID
Initial Temperature	60c for 5mins
First Rate	15c/mins for 14mins and maintain for 3min
Second Rate	10c/mins for 5mins and maintain for 4mins
Mobile Phase or Carrier	Nitrogen
Nitrogen Column Pressure	30psi
Hydrogen Pressure	28psi
Compressed Air Pressure	32psi

Procedure

The dried, homogenized samples (0.5g each of yellow and white maize) were dehydrated to constant weight. Samples were transferred to 250ml conical flasks and subjected to triple petroleum spirit extraction (30ml per cycle) using a thimble-equipped Soxhlet apparatus. Complete hydrolysis required three treatment cycles to ensure amino acid liberation. The defatted samples underwent alkaline digestion (1M KOH, 30ml) in sealed borosilicate vessels at 110°C for 48 hours. Post-hydrolysis neutralization (pH 2.5-5.0) preceded cation-exchange SPE purification. PAHs were subsequently derivatized with ethyl chloroformate following standard protocols.

Heavy Metal Sample Analysis

Sample Incineration

5g aliquots of each maize variety were weighed into pre-labeled crucibles and heated on a hot plate at 150°C until smoke emission ceased. The samples were subsequently transferred to a muffle furnace for complete ashing at 550°C over 12 hours. Following this incineration process, the digested samples were removed from the furnace for further analysis.

Sample dilution

All glassware (volumetric flasks, stirring rods, and funnels) underwent nitric acid washing prior to use. For sample digestion, 30 mL of nitric acid was introduced to each crucible containing the ashed samples, followed by thorough mixing with a glass rod. The resulting solution was vacuum-filtered through Whatman filter paper into prepared volumetric flasks.

Atomic Abosrptioin Spectrophotometer (AAS)

This analytical method is based on the Beer-Lambert principle establishing a direct correlation between absorbance and analyte concentration. Absorption spectrometry quantifies sample components by comparing against standardized solutions. The system employs an element-specific cathode lamp emitting characteristic wavelengths, with an acetylene flame atomizer converting samples to free atoms. A monochromator isolates the resonant wavelength, while a photomultiplier detects and amplifies the signal. Measurement involves first establishing a baseline flame reading, then determining sample concentration through differential light absorption.

III. Result

Table 1 shows the concentration of Heavy metals (mean and standard deviation)

Metal	Mg(ppm)	Cd(ppm)	Fe(ppm)	Ni(ppm)	Pb(ppm)	Zn(ppm)	Cu(ppm)
yellow maize	12.024±0.005	0.018±0.0012	1.912±0.0009	0.03±0.0050	0.013±0.0009	0.356±0.007	0.136±0.0045
white maize	8.105±0.007	0.014±0.0018	1.315±0.0008	0.027±0.0040	0.01±0.0028	0.235±0.0023	0.129±0.0034

Figure 1 shows the concentration of the heavy metals in a Bar chart

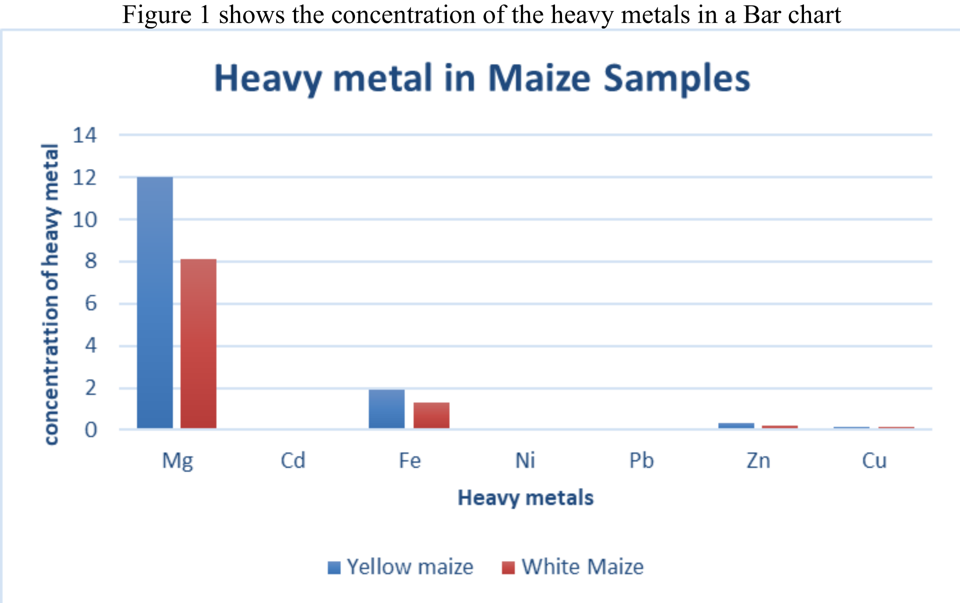


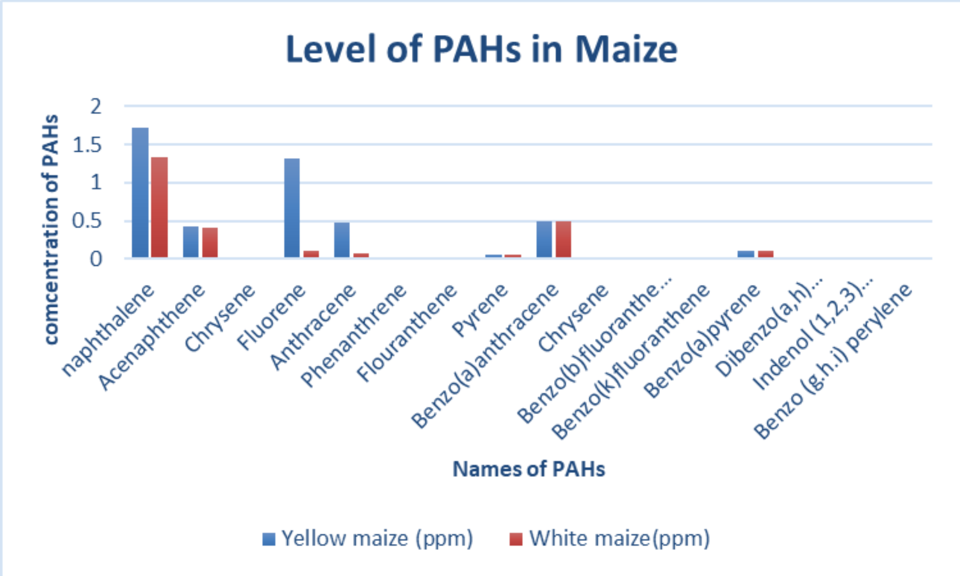
Table 1 shows a distinct concentration hierarchy in the maize samples, with magnesium showing the highest levels, followed by iron, zinc and copper in descending order. Other trace metals were detected at negligible concentrations.

Table 2; shows the concentration of PAHs in the Maize samples

Name of PAHs	Yellow maize (ppm)	White maize(ppm)
naphthalene	1.72014	1.34012
Acenaphthene	0.42127	0.40465
Chrysene	Not detected	Not detected
Fluorene	1.31021	0.10021
Anthracene	0.48012	0.08012
Phenanthrene	Not detected	Not detected
Flouranthene	Not detected	Not detected
Pyrene	0.06248	0.06136
Benzo(a)anthracene	0.49451	0.49451
Chrysene	Not detected	Not detected
Benzo(b)fluoranthene	Not detected	Not detected
Benzo(k)fluoranthene	Not detected	Not detected

Benzo(a)pyrene	0.11167	0.11167
Dibenzo(a,h) anthracene	0.009	0.009
Indenol (1,2,3) pyrene	Not detected	Not detected
Benzo (g.h.i) perylene	Not detected	Not detected

Figure 2 shows the concentration of the PAHs in a Bar chart



The concentration of Naphthalene, Benzon(a)anthracene, anthracene, acenephathene and fluorene is significant when compared to the level of concentration of the other PAHs

IV. Discussion And Conclusion

The current finding indicates that there was a moderate concentration of PAHS in the various maize sample samples. Even while the concentration of these PAHs suggests that eating these crops will have little to no impact on human health, ongoing anthropogenic activities that expose these PAHs to the soil can cause their levels to rise. In the samples that were tested, the levels of antracene, benzo(a)pyrene, acenephtalene, benzo(a)anthracene, pyrene and dibenzo(a,h)anthracene are very low compared to those of the two species of maize. In the various samples, there were no further PAHs found.

The results on the concentration of magnesium in this study are very low compared to the values obtained by Olu et al., 2013 who carried out the evaluation of heavy metal concentration in maize, with magnesium having the highest concentration in all the samples, with the highest level of magnesium being found in Yellow maize 12.024±0.005 ppm and the lowest in White maize 8.105±0.007 ppm. The concentration of heavy metals in the various samples is also below WHO permissible limits. Among all the samples that were evaluated, iron concentration is the next-highest concentration. The highest zinc concentrations were found in yellow maize, which had a concentration of 1.912±0.0009 ppm, and white maize, which had a concentration of 1.315±0.0008 ppm. Yellow maize has a copper value of 0.136±0.0045 ppm. The other samples have very low levels of heavy metal concentration and are all below WHO acceptable limits. Compared to results from Olu et al.'s 2013 study, this study's heavy metal concentration result is lower.

The disparity in anthropogenic activities in the different sampling environments is what caused the results of this study to be lower than those obtained by other authors, such as Afolayan 2018 and Olu et al., 2013. The quantity of PAHs and heavy metals in these crops is inversely correlated with the amount of industrial activity in the farming environment.

Conclusion

Because of the low concentration of PAHs and heavy metals in these samples, consuming them won't cause much harm to the consumer. Despite the fact that prolonged exposure to these low concentrations of PAHs and heavy metals can lead to mild damage through bioaccumulation in the human body.

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