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EVALUATION OF THE AERIAL DEPOSITS OF HEAVY METALS IN FRUITS SOLD BY THE ROADSIDE WITHIN ENUGU METROPOLIS

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ABSTRACT: *Studies were carried out to evaluate the aerial deposits of heavy metals in fruits sold by the roadside within Enugu metropolis, using standard analytical procedures and instrumentation. At 0, 1 and 7 days of roadside exposure, the cucumber samples had mean Pb levels of 0.211±0.032, 0.224±0.011 and 0.247±0.050 µg/g respectively. Also, at 0, 1 and 7 days of roadside exposure, the cucumber samples had mean Cu levels of 1.075±0.134, 1.079±0.130 and 1.086±0.145 µg/g respectively. Similarly, the mean Pb levels in the apple samples at 0, 1 and 7 days of roadside exposure were 0.282±0.014, 0.283±0.010 and 0.296±0.015 µg/g respectively. Copper had mean levels of 0.864±0.136 , 0.864±0.096 and 0.868±0.055 µg/g in the apple samples at 0, 1 and 7 days respective road side exposure. For the two samples, the mean levels of the metals at the investigated roadside exposure durations were less significant. The metals were at their threshold limits in the fruit samples at the investigated durations of exposure.*

KEYWORDS: Apple, Cucumber , Vehicular activities ,Heavy metals and Roadside exposure duration.

INTRODUCTION

Emissions from vehicles is a very serious environmental issue today affecting man both in the urban and rural centres in many developing countries. This is more worrisome now in view of the near non-existent emission control regulations as it relates to vehicular activities in virtually all developing countries (Okeke *et al*., 2020). Vehicular emission is a significant contributor to air pollution in many cities of many developing countries as a result of increased vehicular activities. Okeke *et al*. (2020) observed that outdoor air pollution from vehicular activities contribute to many health problems affecting people of all classes in both the high- and low-income countries of the world. Ekundayo and Fatoba (2020) reported that air pollutants arising from vehicular emissions included heavy metals, particulate matter, oxides and polycyclic aromatic hydrocarbons. Of emphasis to the environmentalists and health regulatory authorities is heavy metals due to its ubiquity, persistency, toxicity and non-biodegradability (Ezeh *et al*., 2019; Okeke *et al*., 2020; Aniobi *et al*., 2023; Nwanya *et al*., 20231; Okeke *et al*., 2024). During fuel combustion and mechanical abrasion of specific parts of vehicles such as clutches, brakes and tyres, particulates of heavy metals in dust and gaseous form are aerially deposited on the environment. Adamiee *et al*. (2016) stated that aerial deposition of heavy metals on the environment, especially the road sides, involves both exhaust and non-exhaust emissions from vehicular activities.

Increased vehicular activities within a given environment to a great extent determines the concentrations of the heavy metals aerially deposited, especially to nearby environments. Harrison *et al*. (2001) and Al-Taani *et al*. (2019) were in conformity with their reports that the concentration of the heavy metals aerially deposited on any given environment particularly from vehicular activities depend to a great extent on the age of the vehicles, quality of oil, type of fuel and frequency of service of the vehicles on the road.

Non-exhaust and exhaust sources of aerial deposition of heavy metals are a disturbing phenomenon in our environment due essentially to the near consistent exposure to it by many people and the health danger it portends. Residential houses, vegetations and farmlands situated near major highways in many cities across Nigeria are bearing the burden of heavy metal pollution from vehicular activities (Ekundayo & Fatoba, 2016). Many heavy metals such as lead, cadmium, copper, zinc and arsenic among others are particles in form of dust or gaseous particulates from exhaust and non-exhaust sources during vehicular activities. Therefore, these heavy metals are deposited as precipitates or particulate matter on vegetations and food materials adjacent to roads. In order to increase the visibility of their produce, farmers and retailers alike display fruits at roads in many Nigerian cities, including Enugu metropolis. Fruits are consumed by the people to increase their wellbeing and promote healthy living. Aniobi *et al*. (2021) stated that fruits when consumed regularly lower the risk of cardiovascular diseases and high blood pressure, increase digestion, and possess both anti-bacterial and anti-inflammatory properties.

In many Nigerian cities, especially Enugu metropolis, the indiscriminate display of fruits at road sides by fruit vendors is a common scene. These fruit vendors sell their wares to willing buyers in order to earn a living but are ostensibly oblivious of the potentiality of the roadside exposed fruits to accumulate heavy metals that could pose toxicity challenges to the fruit consumers. Heavy metals are persistent; they do not biodegrade when present in any environment and, therefore, their toxicities to man is well documented (Okeke *et al*., 2018; Okeke *et al*., 2020; Aniobi *et al*., 2023). Because of the increased vehicular activities within

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Enugu metropolis due to urbanization and the increased patronage of roadside fruits by passengers, commuters, pedestrians and residents, studies were carried out to evaluate the aerial deposits of heavy metals in selected roadside sold fruits, with a view to understanding the public concern that the consumption of such fruits has, especially with regards to exposure to heavy metals.

MATERIALS AND METHODS

The cucumber samples were purchased at the places of harvest while the apple samples were purchased at wholesale depots. The samples were cleverly marked for proper identification and placed in a mix of fruits sold at roadside junctions by fruit vendors, having obtained their consent. At the expiration of each of the investigated roadside exposure duration (0, 1 and 7 days), the samples were immediately taken to the laboratory for preparation and analysis of heavy metals.

Sample Preparation

The samples were each oven-dried to a constant weight and ground to a powdery form in order to increase the reaction rate. They were subsequently stored in well labelled laboratory containers prior to analysis.

Heavy Metal Determination

Two grams (2 g) of each of the ground samples were weighed into Kjeldahl's flask mixed with 20 ml of concentrated sulphuric acid, perchloric acid and nitric acid in the ratio of 1 : 4 : 40, and left to stand overnight. Subsequently, the sample mixture was initially heated to 70^{o}C for about 40 min, and later increased to 120^{o}C. The digestion procedure was termed to have been completed when the solution mixture became clear, with appearance of fumes. The sample digest was diluted with 20 ml of distilled water and boiled for 15 min. The solution was cooled and transferred into a 100 ml volumetric flask and made up to mark with distilled water. The digest was filtered with whatmann filter paper into polyethylene bottles and this procedure was replicated in all the samples. The digest was aspirated into an atomic absorption spectrophotometer (AAS), PG 550 model (Aniobi *et al*., 2021).

Due precautions were taken in carrying out the analysis to avoid possible contamination of the samples.

Statistical Analysis

The data obtained were expressed in mean and standard deviation and subjected to one-way analysis of variance (ANOVA) at 5% confidence level using IBM SPSS 23.0.

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RESULTS AND DISCUSSION

Table 1: Mean heavy metal levels in the cucumber samples at varying periods of roadside exposure

Sample exposure duration Metal (µg/g)	0 day	1 day	7days	F test P value	WHO STD (WHO , 2014)
Pb	0.211±0.032	0.224±0.011	0.247±0.050	0.06	0.5
Cu	1.075±0.134	1.079±0.130	1.086±0.141	0.05	10

Table 2: Mean heavy metal levels in the apple samples at varying periods of roadside exposure

Sample exposure duration Metal (µg/g)	0 day	1 day	7days	F test P value	WHO STD (WHO , 2014)
Pb	0.282±0.014	0.283±0.010	0.296±0.015	0.08	0.5
Cu	0.864±0.136	0.864±0.096	0.868±0.055	0.10	10

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Lead

The result in Table 1 shows that the mean Pb levels in the cucumber samples at 0, 1 and 7 days of roadside exposure were 0.211±0.032, 0.224±0.011 and 0.247±0.050 µg/g respectively. Also, the result of Table 2 shows that the mean Pb levels in the apple samples at 0, 1 and 7 days of roadside exposure were 0.282±0.014 q, 0.283±0.010 and 0.296±0.015 µg/g respectively. A striking but similar observation of the results in Tables 1 and 2 was that the mean Pb levels of the two studied samples increased with increase in the investigated roadside exposure durations (i.e., 0 to 7 days). In addition, for both samples, the mean Pb levels at the investigated roadside exposure durations were less significant. (See Figures 1 and 2.)

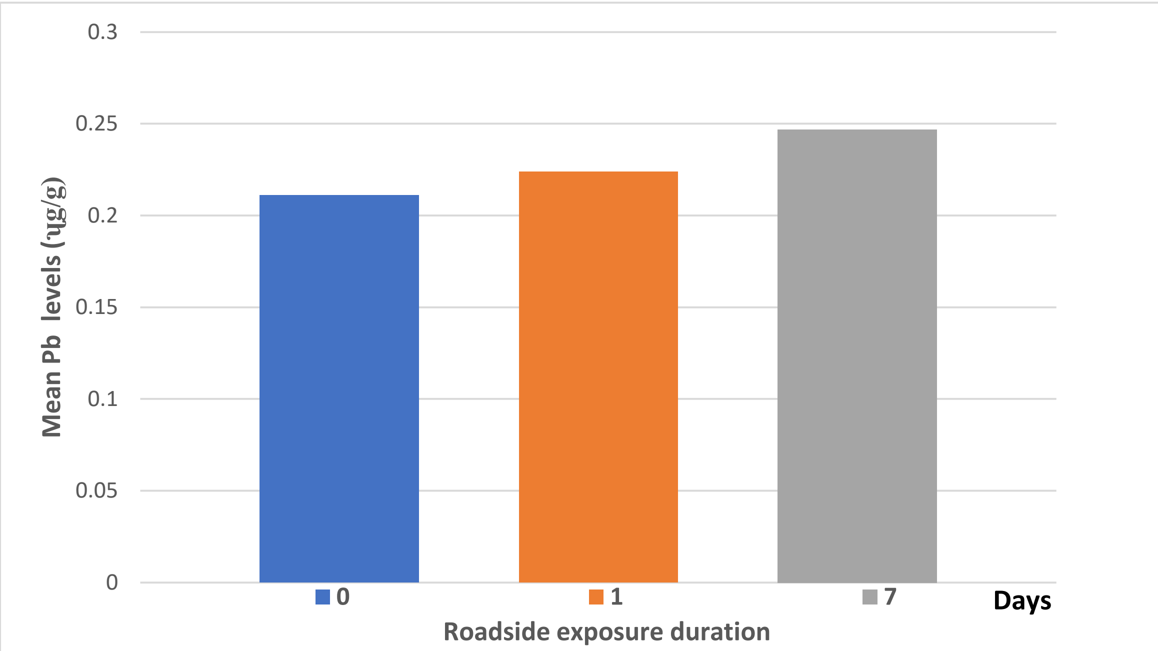

Figure 1: Bar chart representation of the mean Pb levels in the cucumber samples at varying roadside exposure durations

The mean Pb levels in the studied cucumber and apple samples at the investigated roadside exposure durations were within the recommended permissible limits. Although this observation was encouraging, the mere fact that there were aerial deposits of this heavy metal on the roadside fruit samples meant for human consumption, whose concentration increased with increase in the durations of exposure, should be a concern to every fruit consumer and particularly health regulatory authorities.

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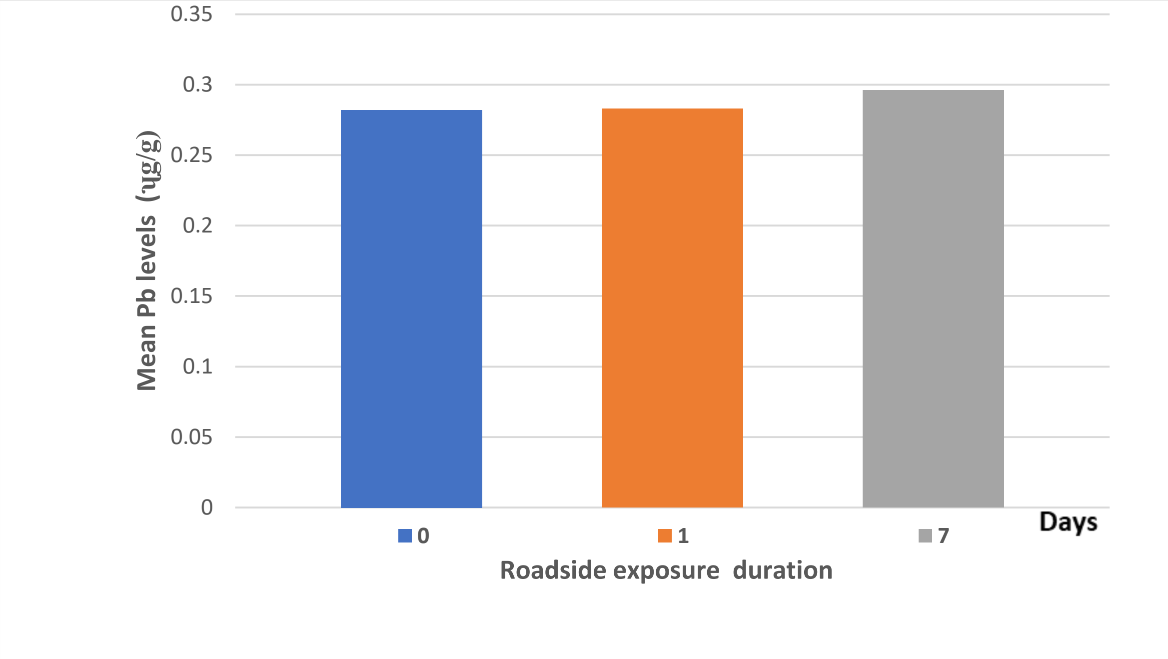

Figure 2: Bar chart representation of the mean Pb levels in the apple samples at varying roadside exposure durations

Enugu metropolis has witnessed increased vehicular activities in recent times due mainly to increased immigration of people occasioned by the peaceful nature and increased economic activities in the city. Therefore, aerial deposition of Pb on roadside fruits sold to people was not unusual. The findings of this research was corroborated by Kemp (2002), who reported that heavy metals such as Pb and Cd are aerially deposited on soils and environments of increased vehicular activities through fuel combustion and oil deposition. Lead is a human toxicant and its toxicity to man has been well documented (Ezeh *et al*., 2019; Ezeagwu *et al*., 2023; Okeke *et al*., 2023).

Copper

The result in Table 1 shows that the mean Cu levels in the cucumber samples at 0, 1 and 7 days of roadside exposure were 1.075±0.134, 1.076±0.130 and 1.086±0.141 µg/g respectively. In the same vein, the result in Table 2 shows that the mean Cu levels in the apple samples at 0, 1 and 7 days of roadside exposure were 0.864±0.136, 0.864±0.096 and 0.868±0.055 µg/g respectively. Just as reported for Pb in the two studied fruit samples, the mean Cu levels increased with increase in roadside exposure duration for both fruit (cucumber and apple) samples. The mean Cu levels in the two investigated fruit samples at the varying roadside exposure durations were equally less significant. (See Figures 3 and 4.)

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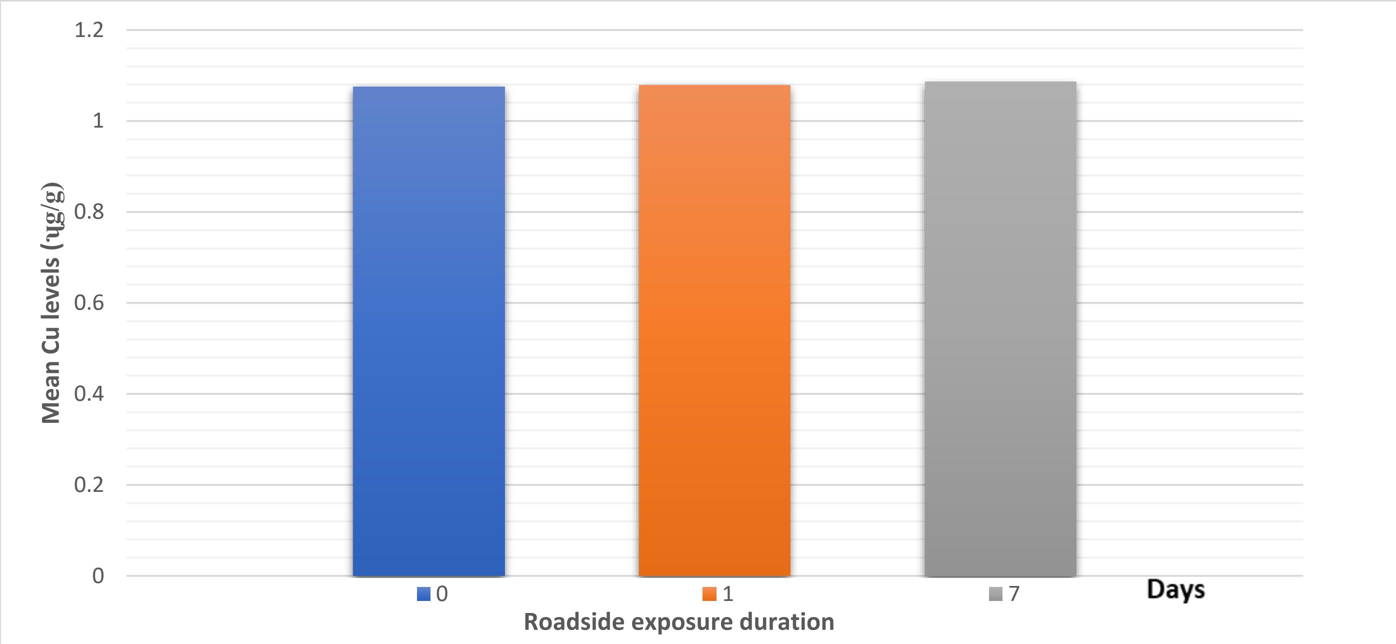

Figure 3: Bar chart representation of the mean Cu levels in the cucumber samples at varying roadside exposure durations

The mean Cu levels in the fruit samples at the investigated exposure durations were within the recommended threshold limits.

According to Ekundayo and Fatoba (2020), roadside soils and vegetations are contaminated with heavy metals such as Cu and Zn through the wear of clutches and brakes (i.e., non-exhaust sources) during vehicular activities, thus explaining the observed presence of Cu in the studied samples.

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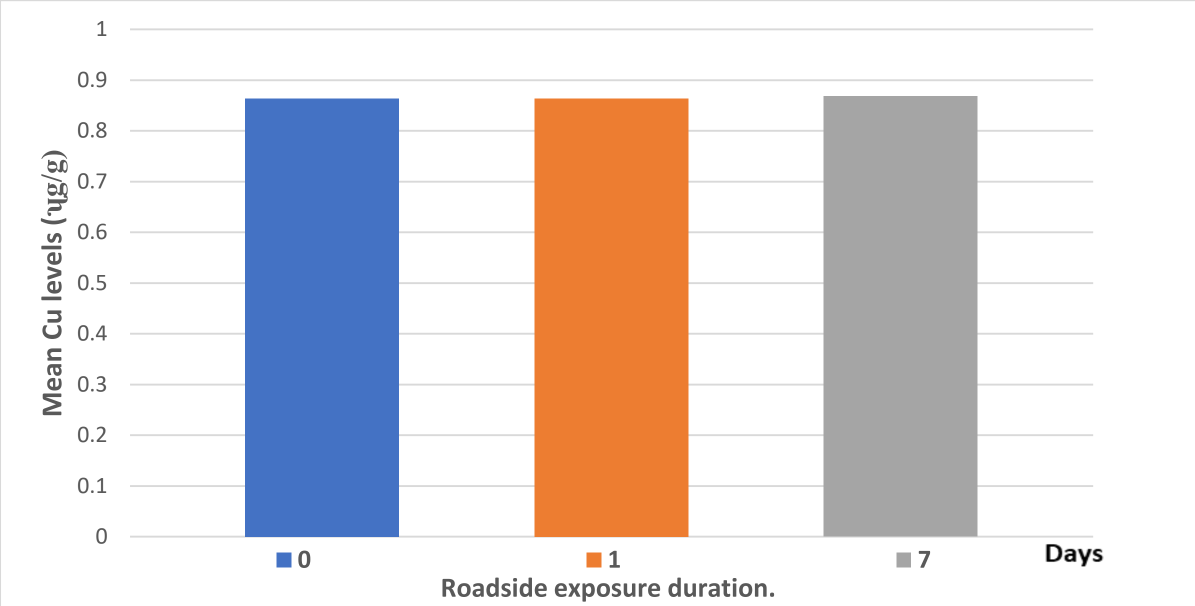

Figure 4: Bar chart representation of the mean Cu levels in the apple samples at varying roadside exposure durations

Although copper is a trace element required in minute amount for the body's biochemical activities, increased exposure to it at consistent levels can result in excessive retention in the liver and cause damages, as described by Okeke *et al*. (2018), Ezeh *et al*. (2018), Aniobi *et al*. (2021) and Aniobi *et al*. (2023).

CONCLUSION

The two studied metals (Pb and Cu) were present in the fruit (cucumber and apple) samples at the investigated roadside exposure durations. The mean levels of the metals in the fruit samples were observed to be within their threshold limits and increased in the samples with increase in the roadside exposure duration. Of the two studied metals, Pb was observed to have a higher mean level in the two fruit samples compared to Cu, and this could be as a result of the exhaust emission of the metal (Pb), which results in higher aerial deposition with increased vehicular activities. It was the submission of this research that exhaust emissions of heavy metals such as Pb and Cd pose a greater danger to the undue exposure to heavy metals on roadside environment than non-exhaust emission sources. Because fruit business is common at roadsides and receives daily patronage by all categories of the people, government regulation of it to secluded areas that witness minimal vehicular activities would greatly help in minimizing the level of exposure to heavy metals by the people.

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CONFLICTS OF INTEREST

The authors of this research bear no conflict of interest in carrying out this research and its publication.

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