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# Analysis and Evaluation of the Effect of Heavy Metals in Fruits and Vegetables

**Hassan Abdullahi**

Senior Lecturer, Department of Petroleum and Natural Gas Processing,
Petroleum Training Institute (PTI), Effurun, Nigeria

**ABSTRACT**

Heavy metal contamination of fruits and vegetables cannot be undervalued as they are vital components of human diet. Fruits and vegetables are rich sources of vitamins, minerals, and fibers, and also have beneficial anti oxidative effects. However, intake of heavy metal-contaminated fruits and vegetables is a threat to human health. In this research work, the analysis and evaluation of the effect of heavy metals in fruits and vegetables were investigated. The apparatus/equipment used in this research work include atomic absorption spectrometer (AAS) Model (Perkins Elmer A analyst 100), weighing balance, blending machine, plungers/syring, beaker (100 ml), funnel, white man filter paper, distilled water, wash bottle, cotton wool, squeezer, volumetric flask and pipette (10 ml). Fruits and vegetables samples were collected from local market in Nigeria. The selected fruits and vegetables used in this present work include; orange fruit, pineapple fruit, water leaf, and pumpkin leaf. The analysis is basically connected with the analytical determination of the heavy metals (i.e., lead, zinc, iron, nickel, copper and cadmium) concentration present in fruits and vegetables. The analyses of the aforementioned heavy metals were conducted with an Atomic Absorption spectrometer (AAS) with model Perkins Elmer AA100. The results obtained reveal that Iron has the highest value of concentration followed by Zinc in all samples analyzed. However, the concentration of metals present in the selected fruits and vegetables were below the maximum permissible limit of 0.30mg/l which is WHO/FAO standard except for Iron (Fe). Thus, the fruits and vegetables can be consumed.

***KEYWORDS****: Heavy metals, Vegetables, Fruits, Contamination, Concentration, Human health*

## 1. INTRODUCTION

Heavy metals are generally metallic compound with relatively high density and are toxic or poisonous at low concentration (Bowen, 1995). This group of metals include Mercury (Hg), Cadmium (Cd), Arsenic (As), Chromium (Cr), Lead (Pb), Zinc (Zn), Copper (Cu), Iron (Fe) and Calcium (Ca). They are usually natural components of the earth (Agrawal, 2003). There are different sources of heavy metals which are pollutants to the environment and living organisms and their sources include chemicals and physical weathering of igneous and metamorphic rocks. Also, other contributions include the decomposition of plant and animal detritus, precipitation of atmospheric depositions, airborne particles from volcanic activity, wind erosion, forest fire, plant exudates and oceanic spray (Marshall, 2004). Heavy metal contamination of fruits and vegetables are common phenomenon and fruits and vegetables are important components of human diet. Fruits and vegetables are rich sources of vitamins, minerals, and fibers, and also have beneficial anti oxidative effects. Conversely, intake of heavy metal-contaminated fruits and vegetables pose a serious risk to the human health ()Radwan and Salama, 2006). Contamination food items by heavy metals are one of the most important aspects of food quality assurance (Khan and Zhu, 2008). Moreover, rapid and unorganized urban and industrial developments have contributed to the elevated levels of heavy metals in the urban environment of developing countries such as Nigeria (Radwan and Salama, 2006), Iran ()Maleki and Zarasvand, 2008, and India (Triantafyllou and Zachariadis, 2001). Often times, emissions of heavy metals from industries and vehicles are deposited on the vegetable surfaces during their harvest, transport and marketing.

According to Jassir *et al.,* (2005), there were deposits of elevated levels of heavy metals in vegetables sold in the markets at Riyadh city in Saudi Arabia due to atmospheric deposition. Also, Sathawara *et al.,* (2004) reported that atmospheric deposition can significantly elevate the levels of heavy metals contamination in vegetables commonly sold in the markets of Varanasi, India. In same line, Eziegbo *et al.,* (2012) observed high level of heavy metals concentration in vegetables from selected market in Anambra State, Nigeria. The prolonged consumption of unsafe concentrations of heavy metals through foodstuffs may lead to the chronic accumulation of heavy metals in the kidney and liver of humans causing disruption of numerous biochemical processes, leading to cardiovascular, nervous, kidney and bone diseases (Igwegbe *et al.,* 1992).

Furthermore, heavy metals such as Cu, Zn, Mn, Co and Mo act as micronutrients for the growth of animals and human beings when present in trace quantities, whereas others such as Cd, As, and Cr act as carcinogens (Parveen and Rafiq, 2003). The contamination of fruits and vegetables with heavy metals due to soil and atmospheric contamination poses a serious threat to its quality and safety. Besides, dietary intake of heavy metals also poses risk to animals and human health. Heavy metals such as Cd and Pb have been shown to have carcinogenic effects (Parveen and Rafiq, 2003). Research work has shown that high concentrations of heavy metals (Cu, Cd and Pb) in fruits and vegetables were related to high prevalence of upper gastrointestinal cancer (Jarup, 2003). Considering the hazardous nature and its effect with food stuffs contamination, regulations were set up in many countries to control the emission of heavy metals. Additionally, the uptake of heavy metals in vegetables are influenced by some factors such as climate, atmospheric depositions, the concentrations of heavy metals in soil, the nature of soil on which the vegetables are grown and the

degree of maturity of the plants at the time of harvest (Fytianos *et al.,* 2001). Air pollution is also a threat to post-harvest vegetables during transportation and marketing, causing elevated levels of heavy metals in vegetables (Agrawal, 2003). Is in this line, this present work is focused on the analysis of the effect of heavy metals in different fruits and vegetable to establish some recommendations on human diet safety. This is particularly important for monitoring fruits and vegetables products from Nigeria farm, where only limited data on the heavy metals content are available. Although, related research works have been carried out but the knowledge about the contamination of fruits and vegetables with heavy metals from Effurun Market, Nigeria which is surrounded with crude oil refinery and other industries is yet to be established. Therefore, the present study was undertaken with the aim to analyze the concentration of some specific heavy metals found in some selected fruits and vegetables from Effurun Market, Nigeria.

## 2. MATERIALS AND METHODS

### 2.1 Apparatus/ Chemical Used

The following apparatus/equipment and chemicals were used for this research work: Atomic absorption spectrometer (AAS) Model (Perkins Elmer A analyst 100), weighing balance, blending machine, plungers/syringe, beaker (100 ml), funnel, filter paper, distilled water, wash bottle, cotton wool, squeezer, volumetric flask and pipette (10 ml). The chemical used was Hydrogen trioxonitrate (V) acid ($HNO_3$).

### 2.2 Sample Collection

Samples of fruits and vegetables leaves were collected from Effurun market, Nigeria. For the analysis, only the edible portions of each fruits and vegetables were used. Orange fruit, pineapple fruit, water leaf, and pumpkin leaf were used for this research work.

### 2.3 Extraction of Vegetable and Fruit Sample (Juice)

The collected samples of fruits and vegetables was thoroughly washed and rinsed with distilled water. 5 g of vegetable leaves was weighed with weighing balance and blended using a blending machine. The juice (water) from the vegetable leaves was filtered using a plunger with a cotton wool placed inside. The cotton wool help to hold back the vegetable leaves particles and prevent it from getting through into the filtrate. One millimeter of 1:1 $HNO_3$ was added to the extracted juice to preserve it for analysis in the refrigerator. For the fruit sample, the fruit was half into four pieces, each pieces was squeezed to extract the juice from the fruit sample. A plunger/syringe was also used to filter the juice and also prevent juice particles from entering into the filtrate. Again, it was also passed through a filter paper to remove smaller juice particles that must have escape through the plunger. One millimeter of 1:1 $HNO_3$ was also added to the extracted juice sample to preserve it and it was stored in the refrigerator ($<4^0C$) until analyzed.

### 2.4 Preparation of Standard Solution

Standard stock solution of the heavy metals, namely lead (Pb), cadmium (cd), copper (cu), iron (Fe), Zinc (Zn), and Nicked (Ni) were prepared. Each of the standard solution contains 1000µg/l (1000 ppm).

### 2.5 Experimental Procedure

The analysis of heavy metals concentration namely Lead (Pb), Iron (Fe), Zinc (Zn), Cadmium, Copper (Cu), Nickel (Ni) in fruits and vegetables samples were carried out using AAS equipment. The atomic absorption spectrometer (AAS) was set up for the analysis according to manufacture instruction. The choice lamp was inserted into the turner and the operation condition such as wave length and slit width adjusted as required. The instrument was optimized for maximum sensitivity using the wavelength and lamp of alignment knob. The numbers and values of the standards were fed into the system with the correct burner in place; air was turned on, followed by acetylene at the appropriate pressure. The flame was ignited and left for about 10 minutes. The absorbance of the blank was adjusted to zero after which the reading of the standard solution with concentration in ppm for each of the metal were taken. This was repeated for each parameter to be obtained in each of the given sample. The equipment was then put in the analytical mode and the individual sample was measured and recorded by aspirating each sample in the instrument. The concentration of the heavy metal in the fruits and vegetable samples were determined.

## 3. RESULTS AND DISCUSSION

The results obtained show variations in the concentration of heavy metals present in fruits and vegetables analyzed. The concentration of Zn and Cu are within the permissible limit, while that of Fe is slightly higher in water leaf and pumpkin leaf (Table 2). Iron (Fe) is an essential element in human and it plays a vital role in the formation of hemoglobin oxygen and electron transport in human body. Cadmium (Cd) is a non- essential element in food and natural waters and it accumulates principally in the kidneys and liver. From this analysis, its concentration is higher in pineapple fruit (0.01mg/l) (Fig. 3) and pumpkin leaf (<0.01 mg/l) (Table 1) compared to the maximum permissible limit of 0.20 mg/l recorded by WHO/ FAO. Nickel (Ni) is an element that occurs in our environment and it is essential in small doses, but it can be dangerous when maximum tolerable amounts are exceeded. This can cause various kinds of cancer in different sites of the body; its concentration in the samples analyzed varies. On the other hand, if Lead (Pb) accumulates in the brain, it can leads to plubism in children. In children it leads to lower acute or chronic toxicity problems, short attention span, hyperactivity and metal deterioration, Loss of memory and weakness of joints have been reported in adults, the results from this study showed that the concentration of lead (Pb) in all the samples ranged between 0.10mg/l in orange fruit and 0.20mg/l in pineapple fruit (Table 1). Its concentration in vegetable leaf (water leaf) was 0.003mg/l and in pumpkin leaf was 0.002mg/l (Table 2). These values is below the maximum permissible limit of 0.30mg/l for orange, pineapple, water leaf and pumpkin leave respectively by WHO/FAO standard.

**Table1. Concentration of Heavy Metals in Fruits**

| Metals | Orange Fruit | Pineapple Fruit | WHO/FAO allow able limit | Unit |
|---|---|---|---|---|
| **Zinc (Zn)** | 0.36 | 0.54 | 60.0 | mg/l |
| **Copper (Cu)** | 0.20 | 0.47 | 40.0 | mg/l |
| **Iron (Fe)** | 1.22 | 0.80 | 0.80 | mg/l |
| **Cadmium (Cd)** | <0.01 | 0.01 | 0.20 | mg/l |
| **Nickel (Ni)** | <0.01 | 0.18 | 0.14 | mg/l |
| **Lead (Pb)** | 0.10 | 0.20 | 0.30 | mg/l |

**Table2. Concentration of Heavy Metals in Vegetable Leaves**

| Metals | Water leaf | Pumpkin leaf | WHO/FAO allowable limit | Unit |
|---|---|---|---|---|
| **Zinc (Zc)** | 0.95 | 0.60 | 60.0 | mg/l |
| **Copper (Cu)** | 0.08 | 0.08 | 40.0 | mg/l |
| **Iron (Fe)** | 0.70 | 0.81 | 0.80 | mg/l |
| **Cadmium (Cd)** | <0.01 | <0.01 | 0.20 | mg/l |
| **Nickel (Ni)** | <0.01 | <0.01 | 0.14 | mg/l |
| **Lead (Pb)** | 0.003 | 0.002 | 0.30 | mg/l |

*WHO: World Health Organization, * FAO: Food and Agricultural Organization

## 4. CONCLUSION

The outcome of the research work shows that the heavy metals concentration in some selected fruits and vegetables analyzed did not exceed the maximum permissible limit as prescribed by the WHO and FAO except for Iron (Fe). The concentration of the heavy metals is in the decreasing order for fruits Fe>Zn>Cu>Pb>Ni>cd and for vegetables leaves Zn>Fe>Cu>Cd>Ni>Pb. Hence, from the result obtained, it can be deduced that orange fruits and vegetable leaves within Effurun, Nigeria are safe for consumption.

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