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# Spectrometric Determination of Selected Heavy Metals in Plant Tissues in Kisii County.

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***Abstract*****-- Heavy metals are non-biodegradable and therefore they remain in ecological systems and in the food chain indefinitely, exposing top-level predators to very high levels of pollution. Elevated levels of heavy metals in natural environment may have a detrimental effect on both human health and the environment. Apart from the direct impact on health or environmental problems, water or soil contamination can cause considerable economic and financial damage. Plant samples were air dried and gently ground to pass through a 2 mm sieve and homogenized and stored for analysis. Statistical analysis was conducted on the data to determine the mean and Pearson correlation. According to the analysis of spectrometric technique, the concentrations of the heavy metals in the selected sites were below the recommended levels. The determination of levels of lead, zinc, manganese and cadmium in plant tissues in Kisii County were to be used to sensitize the general population of Kisii County on heavy metal health effects and the importance of environmental conservation. The study was also to inform the authorities in environment management on the level of heavy metal pollution in the County hence providing a reference for future studies on the same.**

## I. INTRODUCTION

### *1.1 Background of The Study*

Environmental pollution is a worldwide problem and the attention of the whole world is mainly focused on the problem which normally results in undesirable changes in the physical, chemical and biological characteristics of air, water and soil, ultimately affecting human life and lives of animals (Masood *et al.,* 2005). Heavy metals are among the environmental pollutants. Toxic metals can disturb important biochemical processes, constituting an important threat to human health and animals. Humans and animals can bio-avail these elements from the soil and sediments by contact with their external surfaces, through ingestion and also from inhalation of airborne particles and vaporized metals (Masood *et al.,* 2005). Presence of heavy metals in the environment poses a number of challenges to humans and animals. Generally, increased exposure to heavy metals in the environment increases the risk of developing terminal diseases like cancer and breathing system. The effect or impact depends on the type of metal species exposed to with some metals causing problems even in their small concentrations in the body (Shrivastav, 2001).

## II. LITERATURE REVIEW

### *2.1 Heavy metal and environment*

There are different types of pollution caused by toxic levels of heavy metal pollutants and is called heavy metal pollution (Bose and Hemantaranjan, 2005). Human biology is full of instances where heavy metal toxicity has led to mass deaths (Shrivastav, 2001). All heavy metals are toxic to living organisms at excessive concentrations. But some are essential for normal health growth and reproduction by plants at low but critical concentrations (Bose and Hemantaranjan, 2005). Metals have no known beneficial effects in either animals or plants and no known homeostasis mechanism for them (Draghici*et al.,* and Vieira *et al*., 2011). These metals are generally considered the most toxic to humans and animals. Their adverse effects include but not limited to neuro-toxic and carcinogenic actions (Castro-Gonzalez *et al*., 2008). Children are generally accepted as highest risk group. They have a higher adsorption rate of heavy metals because of their active digestion system and sensitivity of haemoglobin to heavy metals. This can greatly increase ingestion of metal laden soil particles via hand-to-mouth activities. Adults may be exposed to the threat through inhalation, an easier pathway for toxic metals to enter their body (Fong *et al.,* 2008).

## III. MATERIALS AND METHODS

### *3.1 Plant tissues sample digestion*

Classical wet decomposition technique (i.e. decomposition by mixture of inorganic acids under normal pressure and high temperature) was used for the digestion of the samples. Prior to digestion of the leaves from sampled vegetable and plant, all glassware were thoroughly cleaned by soaking overnight in 2M nitric acid, washed thoroughly with distilled water and dried. Prepared sample was oven dried at 105 $^{o}$C for 24 hours and 0.5g of sample dissolved in 10 ml of concentrated nitric acid and digestion tablet was added. The mixture was heated until all the fumes ceased. Hydrogen peroxide was added drop wise till a colorless solution was obtained and 10 ml distilled water added and mixture was left to cool.

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The solution was filtered through whatman No. 42 filter paper into 100 ml volumetric flask and topped with distilled water then put in clean labeled bottle for analysis using AAS (Buck Scientific 210 VGO Varian Co Ltd; Australia) with appropriate hollow cathode lamp at selected wavelength.

*3.2 Preparation of stock solutions and standards.*

All stock solution were prepared by dissolving 0.5 g to 1 g of metal nitrate in 10 ml of distilled water and then made up to 100 ml of solution using distilled water. Through serial dilutions, standard working solutions of Pb, Mn, Cd and Zn were made which were used to generate calibration curves.

## IV. Results And Discusion

*4.1 Mean heavy metal concentration in leaves for plantsamples*

The determination of heavy metal in leaves for plant samples was done using AAS and electrochemical method. Table 4.1 shows that the mean concentrations of zinc in leaves for plant tissues obtained from Eunice farm, Ratemo farm and control soil were found to be 0.10 mg/kg, 0.12 mg/kg and 0.10 mg/kg and did not differ significantly since the means were closer to one another.

This means that the two farms were not contaminated with Zn. Oyugi and KALRO farms means concentrations were found to be 0.07 mg/kg and 0.06 mg/kg also did not have any significant difference with the mean concentration of control soil. Manganese had a significant difference in Eunice 0.71 mg/kg, Ratemo 0.30 mg/kg, KALRO 0.53 mg/kg farms with the control soil concentration which was 0.46 mg/kg but it did not differ significantly with KALRO 0.53 mg/kg. From literature we found that Mn is the second largest metal on the earth's surface thus, justified why manganese had a significant difference. Lead in Eunice, Ratemo and KALRO farms were below detection limit but some traces were detected in Oyugi farm and control soil. Cadmium had a low detected limit for Eunuce and KALRO farmsbut differed significantly with Ratemo farm and did not differ significantly with Oyugi farm and the control soil. Generally lead was not detected in plants tissues in different farms.

One way ANOVA showed that there was no significant difference in the levels of the heavy metals between the different agricultural farms and the control soil since p-value calculated is less than 95% significant level (p>0.05 at 95 % confidence level).

**Table 4.1**
**Mean heavy metal concentration in leaves for plant tissues**

| Farmer | Zn (mean±SE)mg/g | Mn (mean±SE)mg/g | Pb (mean±SE)mg/g | Cd (mean±SE)mg/g |
|---|---|---|---|---|
| **A** | 0.10±0.01 | 0.71±0.01 | <LOD | <LOD |
| **B** | 0.12±0.00 | 0.30±0.02 | <LOD | 0.13±0.07 |
| **C** | 0.07±0.02 | 0.63±0.11 | 0.01±0.01 | 0.33±0.07 |
| **D** | 0.06±0.00 | 0.53±0.01 | <LOD | <LOD |
| **Virgin land** | 0.10±0.00 | 0.46±0.01 | 0.02±0.00 | 0.32±0.06 |
| **p-value** | <0.062 | <0.071 | <0.397 | <0.128 |

One way ANOVA showed that there was no significant difference in the levels of the heavy metals between the different agricultural farms and the control soil since p-value calculated is less than 95% significant level (p>0.05 at 95 % confidence level).

**Table 4.2**
**Pearson correlation matrix for plant tissues**

| Parameters | Cd | Zn | Mn | Pb |
|---|---|---|---|---|
| **Cd** | 1 | -0.511 | 0.496 | 0.631 |
| **Zn** | -0.511 | 1 | -0.738** | 0.338 |
| **Mn** | 0.496 | -0.738** | 1 | -0.451 |
| **Pb** | 0.631 | 0.338 | -0.451 | 1 |

***Highly significant correlation*

Correlation between metals in the different sites examined was determined using Pearson's correlation coefficient as shown in table 4.3. Same metal-metal element correlation had strong positive correlations and were related linearly, an increase in concentration of one metal ions affects the concentration of the other metal ions by increasing its concentration and a decrease in the concentration of one metal ions leads to the decrease of the concentration of the other metal ions. Metals with negative correlations show an inverse relationship that is an increase in the concentration of one of the metal ions leads to decrease in concentration of the other metal ions. Only Zn and Mn had a highly significant correlation of -0.738.

In summary Pearson correlation indicated that Cd & Cd, Zn & Zn, Mn&Mn and Pb&Pb had a perfect positive correlation because the coefficient matrix is positive one (+1). There is a weak relationship existing between Cd &Mn; 0.496, Zn &Pb; 0.338, and Mn&Pb; -0.451 because the closer the coefficient matrix is to zero the weak the relationship is between the elements. Also a closer relationship is existing between Cd & Zn; -0.511 and Cd &Pb; 0.631 as the coefficient matrix is closer to +1 or -1 but there is a strong closer relationship between Mn& Zn because the coefficient is very closer to -1.The levels of the heavy metals in both the plant and the soil varied significantly in some cases where there could be a higher level on the plant than in the soil or vice versa.

The p-values for zinc and manganese were set <0.001. From table 4.3 it was noted that the two metals in all farms were significant different including the control soil. For cadmium the p-values were set <0.063 from the table above the mean values for cadmium was less than the threshold value therefore the metal is not significant. That is the levels of cadmium in all farms are below the recommended limits. Lead could not be compared statistically because it had a low detection limit.

## V. CONCLUSION

The concentration of the heavy metals that were analyzed (Pb, Zn, Mn and Cd) are all far below the maximum tolerable levels set by WHO for agricultural soil. The results obtained showed that the soil is not polluted by various pollutants and not harmful for recreational and agricultural purposes.

It is therefore suggested that the soil in Kisii County with its low levels of heavy metals should be utilized for agricultural farming. No remediation is needed because the concentration of heavy metals is below the tolerable amount as set by WHO. I recommend that determination of heavy metals be done on various vegetables with the Atomic Absorption Spectroscopy machine due to the fact that the materials used for its development is readily available and cheap.

### *Recommendations*

More research be done in rural areas to determine the status of heavy metal pollution.

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