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# An Assessment of Soil Heavy Metal Pollution by Various Allied Artisans in Automobile , Welding Workshop and Petrol Station in Lagos State, Nigeria

By

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**Abstract-** Levels of some agricultural pollutants, heavy metals ( Cd, Cr, Cu, Ni, Pb Zn,) were investigated in the soils, stems, roots, and leaves of Water leaf (*Talinum triangulare*) obtained from a filling station,mechanic workshop and welding workshop in Lagos state. Concentration levels of the metals were determined using atomic absorption spectrophotometer. Variations of the metals in the *T.triangulare* and soils were in the order: Zn>Lead>Chromium>Copper>Nickel>Cadmium The results obtained showed levels of the metals in soils and vegetables from the sample areas, automobile workshop,weldind aaaworkshop and petrol station which are indications of possible pollution of the sample areas as a result of excessive usage of the locations by activities of the artisans and spills from the filling station. The results were below the permissible levels recommended by United States Environmental Protection Agency and World Health Organization except for Lead in the welding workshop. Therefore consumption of *T. triangulare* as food in the three locations except the welding workshop may not pose health hazards to humans at the time of the study.

***Keywords****: Heavy metals, pollution, Talinum triangulare L) Artisans workshops, Lagos Nigeria.*

## Introduction

*Talinum triangulare* L is a perennial herb that belongs to the family Portulaceae. In some text it also called T*alinum fructicosum*. Ceylon spinach (En). Grassé, pourpier tropical (Fr). Beldroega grauda, lustrosa grande (Po) are some of its aliases. (Leung, W.-T.W., Busson, F. and Jardin, C., 1968). The leaves contain per 100 g edible portion: water 90.8 g, energy 105 kJ (25 kcal), protein 2.4 g, fat 0.4 g, carbohydrate 4.4 g, fibre 1.0 g, Ca 121 mg, P 67 mg, Fe 5.0 mg, thiamine 0.08 mg, riboflavin 0.18 mg, niacin 0.3 mg, ascorbic acid 31 mg (Leung, W.-T.W., Busson, F. & Jardin, C., 1968). The vitamin A content is comparable to other medium green leafy vegetables, about 900 μg.

In view of the above, it is clear that vegetable constitute an important part of the human diet. Vegetables have been shown to contain essential nutrients ascorbic acid, phenolic and Flavonoids compounds, which have oxidative properties. This is by virtue of free-radical scavenging properties of their constituent hydroxyl groups, the extended conjugation across the flavonoid structure and an increasing number of hydroxyl group that enhance the antioxidant properties, allowing them to act as reducing agents ( Kanner *et al* 1995). As a result of these properties they offer protection from peroxidative damages in living systems, thereby playing important role in prevention of carcinogenesis and extension of life span of animals, (Cutler, 1982 and 1992). The health giving properties of these antioxidants include anti-cancer, anti-viral anti-inflammatory activities, effects on capillary fragility and ability to inhibit human platelet aggregation (Huet, 1982, Benavente *et al* 1997). Even though research works have indicated that some common vegetables are capable of accumulating high levels of heavy metals from contaminated and polluted soils *(Cobb et a 2000l*) in Not much information as regards around artisanall workshops especially in urban cities as that of Lagos Nigeria where millions of tons of waste are not well disposed.

In the urban areas, most chemical wastes are from non point source (NPS) especially from auto-mechanic sites, filling stations (via oil spillage) and welding sites. Emissions from the heavy traffic on these road side contain lead (Pb), Cadmium (Cd), Zinc (Zn) and Nickel (Ni), which are present in fuel as anti-knock agents. This has also led to contamination of air and soils on which these vegetables are planted (Ikeda *et al*., 2000).

The waste from the aforementioned areas constitutes a significant level of problems to economic vegetables grown in areas close to them. The spills coming from these areas contain a wide variety of heavy metals that are hazardous to plants and consequently to human health. (Wong et al., 1996 Yusuf et al., 2003). Zinc lead and chromium have a number of applications in basic engineering works such as electroplating and galvanizing and petrochemicals, lead pollution however is through automobiles and battery manufacturers, (Scoffern, John 1861) Most heavy metals infiltrate and accumulate in the top soil. Environmental pollution by heavy metals is a problem that has global dimension and has been accompanied by large scale soil pollution. As human activities increases, especially with the application of modern technologies, pollution and contamination of the human food chain has become inevitable. Heavy metals uptake by plants grown in polluted soils has been studied to a considerable extent (Wong, 1996; Wong *et al*., 1996; Sukreeyapongse *et al*., 2002; Yusuf *et al*., 2003).

Many types of heavy metal resistance and tolerance mechanisms have been suggested, especially for Copper, Zinc, Nickel and Chromium, in plants growing on metalliferous soils

(Turner, 1970; Turner and Marshall, 1971; Antonovics *et al.,* 1971). Fe, Mn and Cu (Turner and Marshall, 1971; Memon *et al*., 1979), Ni and Co (Memon *et al*., 1973), Cd and Zn (Memon *et al*., 1980b), Pb (Brooks, 1983), and Se (Banuelos and Meek, 1990) accumulator plants have been reported. Heavy metal contamination in vegetables cannot be underestimated as these food stuffs are important components of human diet. Heavy metal contamination of the food items is one of the most important aspects of food quality assurance (Marshall, 2004; Radwan and Salama, 2006; Wang *et al*., 2005; Khan *et al*., 2008). Consequently, International and national regulations on food quality have lowered the maximum permissible levels of toxic metals in food items due to an increased awareness of the risk, these metals pose to food chain contamination (Radwan and Salama, 2006) to further protect human lives and this simply implied that we have to stand up and protect our future especially those living in agrarian cites like Lagos Nigeria.

## Materials and Methods

**Study Areas:** African Petroleum (AP) filling station in the railway compound at Ebute – Meta, Federal Ministry of Works Central Workshop division Ijora and an auto mechanic workshop on Baba Londoner Street at Iyana-school along LASU-Isheri road, Lagos Nigeria. These areas have a bimodal rainfall pattern which peaks in June and September.

**Sample and Sampling Procedure:** *Talinum triangulare* (plants) and top soil (0 – 15 cm) samples were collected from the surroundings of the areas. The areas (filling station, welding site and auto mechanic workshop-shop) are at least ten years old. Collections were made in August –December, 2011. Sample collections were carried out according to the methods described by APHA, 1998; samples were put into pre-cleaned polyethylene bags and transported to the laboratory. Each soil sample was air-dried, and all clods and crumbs were removed and mixed uniformly. Soils were sieved through a 2mm sieve to remove coarse particular before sub-sampling for chemical analysis. The soil samples were analyzed for heavy metal contents: Cadmium (Cd), Nickel (Ni), Copper (Cu), Lead (Pb), Zinc (Zn) and Chromium (Cr).

### Determination of Heavy Metal Content of the Soil

A Sample of 5g of air-dried ground soil was transferred to a 25ml conical flask; 5ml of concentrated $H_2SO_4$ was added followed by 25ml of concentrated $HNO_3$, and 5ml of concentrated HCl. The content of the tube were heated at 200 $^oC$ for 1 hour in a fuming hood, and then cooled to room temperature. After cooling, 20ml of distilled water was added and the mixture was filtered to complete the digestion.
Finally, the mixture was transferred to a 50ml volumetric flask, filled to the mark, and allowed to settle for at least 15 hours. The filtrate was analyzed for total Cadmium (Cd), Nickel (Ni), Copper (Cu), Lead (Pb), Zinc (Zn) and Chromium (Cr) by Atomic Absorption Spectrophotometer.

### Determination of Heavy Metal Content in Plants

The whole plants were divided into roots, leaves and stem. The sample were weighed to determine the fresh weight and then dried in an oven at 60°C for 48 hours. The dry samples were crushed in a mortal and the resulting powder was packaged for analysis of the heavy metals. Approximately 5g of the powder was transferred to a 25ml conical flask; 5ml of concentrated $H_2SO_4$ was added followed by 25ml of concentrated $HNO_3$ and 5ml of concentrated HCL. The contents of the tube were heated at 200°C for 1 hour in a fuming hood, and then cooled to room temperature. Then, 20ml of distilled water was added and the mixture was filtered using filter paper to complete the digestion of organic matter.

Finally, the mixture was transferred to a 50ml volumetric flask, filled to the mark, and allowed to settle for at least 15 hours. The resulted filtrate was analyzed for total Cadmium (Cd), Nickel (Ni), Copper (Cu), Lead (Pb), Zinc (Zn) and Chromium (Cr) by Atomic Absorption Spectrometer. This sample procedure was carried out for each plant sample (i.e stem, leaves and root) separately.

### Statistical Analysis

Data collected were subjected to statistical tests of significance. One way analysis of variance (ANOVA) was applied with the help of software SPSS 17. Test of significance were conducted for each of the elements for the following: Mean concentration for heavy metals Nickel (Ni) Lead (Pb), Zinc (Zn) Copper (Cu) Chromium (Cr) and Cadmium (Cd ) in *T. triangulare* plant parts (root, stem and leaves) and soils at different sites (Filling station, welding workshop and mechanic workshop) in addition to their respective standard deviation.

## Results

### Cadmium

Table 2 shows that cadmium concentration is highest in the soil in the mechanic workshop, with a value of 1.153± 0.019 mg/kg and lowest in the leaves of *Talinum triangulare* found in the welding workshop with a value of 0.001 ± 0.001 mg/kg. This suggests that Cadmium concentration is highest in the mechanic workshop. Generally, Cadmium concentration is more in the soil sample than in the plant sample.

### Copper

Table 2 shows that copper concentration is highest in the soil found in the welding workshop with a value of 1.292±0.000 mg/kg and lowest in the leaves of *Talinum triangulare* found in the mechanic workshop with a value 0.001±0.000mg/kg. This suggests that Cu concentration is highest in the in the welding workshop.

### Chromium

Table 2 shows that Chromium concentration is highest in the soil found in the filling station with a value of 11.250±0.000 mg/kg and lowest in the stem of *Talinum triangulare* found in the welding workshop with a value 0.000±0.000mg/kg. This suggests that Chromium concentration is highest in the soil of the filling station.

## Nickel

Table 2 shows that Nickel concentration is highest in the soil found in the mechanic workshop with a value of 2.000±0.001 mg/kg and lowest in the stems and leaves of *Talinum triangulare* found in all the sites with a value 0.000±0.000mg/kg.

## Lead

Table 2 shows that Pb concentration is highest in the soil found in the welding workshop with a value of 2.469±0.001 mg/kg and lowest in the leaves of *Talinum triangulare* found in the mechanic workshop with a value 0.001±0.000mg/kg. This suggests that lead concentration is highest in the soil of the welding workshop.

## Zinc

Table 2 shows that Zinc concentration is highest in the soil found in the welding workshop with a value of 46.875±0.000 mg/kg and lowest in the leaves of *Talinum triangulare* found in the welding workshop with a value 0.667±0.036mg/kg. This suggests that Zinc concentration is highest in the soil welding workshop.

## Discussion

CADMIUM concentration in the plants gotten from the filling stations, mechanic workshop and welding workshop are 0.054 mg/kg,0.135mg/kg,0.022mg/kg respectively, these values are lower than the recommended 1-3mg/kg limit given by EU and FAO/WHO guideline value (EC, 1986). This is in line with the result of (Odai *et al*., 2008) which shows that high metals concentration were found in non-edible parts(Root and Stem) than in edible parts (Leaves).

Chambers and Sidle (1991) also agreed and found that plant metal level vary when related to soil metal level. They also found that metal uptake was controlled by such variables as PH, organic matter content and soil type. However, the present results is in disagreement with (Okunola *et al.,* 2007), with the fact that Cadmium plant level were found lower than soil levels in all of the plants analyzed. This indicates that Cadmium uptake by plant is restricted at these sites by PH or other factors. The low concentrations of Cadmium may b attributed to the metal being non essential for plant growth and metabolism (Shauibu and Ayodele 2002)

The high Cadmium level in the mechanic workshop could be from lubricating oil spent oil, and nickel- cadmium car batteries (Atayese *et al.,* 2009).

Chromium plant concentration ranges from 0.013mg/kg at the welding workshop to 0.572mg/kg at the filling station site. The high concentration of chromium at the filling station may be due to the fact that the station is close to the railway lines. The concentration of chromium decreases from the roots to leaves. The values of chromium concentration are low compared to the WHO/FAO recommended value of 2.3mg/kg on heavy metal concentration in leafy vegetable. This is also in line with the result of (Odai *et al*.,2008).

COPPER plant concentration ranges from 0.120mg/kg at the filling station to 0.311mg/kg at the welding workshop. Soil Copper concentration is higher than plant Copper concentration. The values are low compared to the WHO/FAO recommended value of 99.40mg/kg on heavy metal concentration in leafy vegetable. This is also in agreement with the result of (Odai *et al*.,2008). Copper plant concentrations were lower in the edible parts than non-edible parts. This is in line with the result of (Odai *et al*.,2008) which shows that high metals concentration were found in non-edible parts(Root and Stem) than in edible parts (Leaves). Copper plant concentration in the leaves of *Talinum triangulare* found in the welding workshop was highest compared to the other areas. The highest concentration was found at the mechanic workshop this may be due to the use of copper as automobile body parts, electrical wiring, communication equipment and electromagnets.

Nickel concentration was the lowest out of all the heavy metals analysed. The concentration ranges from 0.002mg/kg at the filling station site to 0.250mg/kg at the welding workshop. The values are low compared to the WHO/FAO recommended value of 5mg/kg on heavy metal concentration in leafy vegetable. Nickel concentration in the roots was very low and consequently none was found in the stem and leaves. This is also in agreement with the result of (Odai *et al.,*2008). The highest concentration was found at the welding workshop this is because nickel is used in various items such as industrial machinery, automobiles automobile batteries and electronic equipment.

Lead concentration analysed ranges from 0.034mg/kg at mechanic workshop to 0.689mg/kg at the welding workshop. The result gotten from the welding workshop (0.689mg/kg) is higher than the recommended value for lead given by WHO/FAO which is 0.3mg/kg. Lead levels in leaves of *Talinum triangulare* gotten from the filling station is the highest (at 0.080mg/kg), it even higher than the concentration in the stem (0.074mg/kg), this contradicts the results of (Odai *et al*., 2008) this may be because of the used of lead as an anti knock agent in petrol as it increases the octane levels of petrol.(Department of the Environment and Heritage, Australian Government. 2001).

ZINC plant content ranges from 9.167mg/kg±0.00 at the filling station to 16.292mg/kg±0.00 in the welding workshop, this value is low compared to the result of (Abechi *et al*.,2010). The values are less than the WHO/FAO recommended value of 99.40mg/kg on heavy metal concentration in leafy vegetable (EC, 1986). Also the highest concentration was found in the root of the plants found at the mechanic workshop (12.250mg/kg), while the least concentration is found in the leaves found at the welding workshop (0.667mg/kg). This is also in line with the result of (Odai *et al*., 2008). However Zinc concentration in the soil sample from welding workshop is highest (46.875mg/kg) but the Zinc concentration found in the roots of mechanic workshop (12.250mg/kg) is slightly higher than the concentration of

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Zinc (11.875mg/kg) in the root found in the welding workshop. This indicates that Zinc uptake by plant is restricted at these sites by PH or other factors.

Also the mobility of the metal depends on the soil PH and also depends on the organic matter and granulometric composition of the soil. (Abechi *et al.,* 2010). The leaf Zinc content of the filling station (1.750mg/kg) is higher than that of the stem content (1.563mg/kg), this does not follow the trend in other part of the plant parts. The primary source of Zinc in this area could be from attrition of motor vehicle tire rubber exacerbated by poor road surface as components of zinc- carbon batteries (Wiaux, J. and Waefler, J.P. 1995) and the lubricating oils in which Zinc is found as part of many additives such as zinc dithiophosphates. The high level of Zinc in these locations (welding workshop and mechanic workshop) is as a result of electroplating and galvanizing processes.

## Conclusion and Recommendation

The results indicate that *Talinum triangulare* vegetable samples analyzed in this study had some levels of heavy metals Cadmium, Copper, Chromium, Nickel, Lead and Zinc. The concentration of metals in plant samples are in the order of Zn>Lead>Chromium>Copper>Nickel>Cadmium. Zinc had the highest concentration of all the metals and its value is lesser than the recommended values set by WHO/FAO. However lead concentrations at welding workshop are higher than the recommended values set by WHO/FAO. The high level of Zinc in these locations (welding workshop and mechanic workshop) is mainly as a result of continual usage of Zinc in electroplating and galvanizing processes. This can lead to accumulation of the metal in the tissues of organisms that feed on the plant and other plants growing around these areas. This can be transferred to other consumers in the food chain which will pose a public health threat especially to the Nigerian population residing in Lagos. Studies have demonstrated that chronic use of zinc as supplements may actually increase the chance of developing prostate cancer, also likely due to the natural build up of this heavy metal in the prostate. Most of the heavy metals discussed have toxic potential but the detrimental impact become apparent only after decades of exposure. It is therefore, suggested that regular monitoring of heavy metals in plant tissues is essential in order to prevent excessive build up of these metals in the human food chain.

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Table 1 shows the mean value content of selected heavy metals present in talinum triangulare and soil with the respective standard deviations and how they vary from one location to another.

| COMPONENT | | LOCATIONS | | | | | |
|---|---|---|---|---|---|---|---|
| | | FILLING STATION | | MECHANIC WORKSHOP | | WELDING WORKSHOP | |
| | | Mean | Std. Dev | Mean | Std. Dev | Mean | Std. Dev |
| SOIL | Cadmium (Mg/Kg) | 0.5 | 0 | 1.153 | 0.019 | 0.248 | 0.001 |
| | Copper (Mg/Kg) | 0.167 | 0.001 | 0.209 | 0.002 | 1.292 | 0 |
| | Chromium (Mg/Kg) | 11.25 | 0 | 10.271 | 0.036 | 8.6 | 0 |
| | Nickel (Mg/Kg) | 0.558 | 0.003 | 2 | 0.001 | 0.96 | 0 |
| | lead (Mg/Kg) | 1.052 | 0.003 | 1.977 | 0.001 | 2.469 | 0.001 |
| | Zinc (Mg/Kg) | 12.813 | 0 | 39.396 | 0.036 | 46.875 | 0 |
| ROOT | Cadmium (Mg/Kg) | 0.041 | 0.001 | 0.125 | 0 | 0.015 | 0 |
| | Copper (Mg/Kg) | 0.067 | 0.001 | 0.008 | 0 | 0.171 | 0 |
| | Chromium (Mg/Kg) | 0.434 | 0.008 | 0.084 | 0.008 | 0.013 | 0.001 |
| | Nickel (Mg/Kg) | 0.002 | 0 | 0.004 | 0.001 | 0.25 | 0.001 |
| | lead (Mg/Kg) | 0.42 | 0 | 0.024 | 0.001 | 0.501 | 0.002 |
| | Zinc (Mg/Kg) | 5.854 | 0.036 | 12.25 | 0 | 11.875 | 0 |
| STEM | Cadmium (Mg/Kg) | 0.01 | 0.001 | 0.008 | 0 | 0.006 | 0.002 |
| | Copper (Mg/Kg) | 0.038 | 0 | 0.007 | 0.001 | 0.102 | 0 |
| | Chromium (Mg/Kg) | 0.1 | 0.001 | 0.037 | 0 | 0 | 0 |
| | Nickel (Mg/Kg) | 0 | 0 | 0 | 0 | 0 | 0 |
| | lead (Mg/Kg) | 0.074 | 0.001 | 0.009 | 0.001 | 0.153 | 0 |
| | Zinc (Mg/Kg) | 1.563 | 0 | 3.125 | 0 | 3.75 | 0 |
| LEAF | Cadmium (Mg/Kg) | 0.003 | 0.001 | 0.002 | 0.001 | 0.001 | 0.001 |
| | Copper (Mg/Kg) | 0.015 | 0 | 0.001 | 0 | 0.038 | 0 |
| | Chromium (Mg/Kg) | 0.038 | 0 | 0.012 | 0 | 0 | 0 |
| | Nickel (Mg/Kg) | 0 | 0 | 0 | 0 | 0 | 0 |
| | lead (Mg/Kg) | 0.08 | 0 | 0.001 | 0 | 0.024 | 0.001 |
| | Zinc (Mg/Kg) | 1.75 | 0 | 0.688 | 0.108 | 0.667 | 0.036 |
| Total | Cadmium (Mg/Kg) | 0.138 | 0.219 | 0.322 | 0.504 | 0.068 | 0.109 |
| | Copper (Mg/Kg) | 0.072 | 0.061 | 0.056 | 0.092 | 0.401 | 0.54 |
| | Chromium (Mg/Kg) | 2.956 | 5.004 | 2.601 | 4.625 | 2.153 | 3.888 |
| | Nickel (Mg/Kg) | 0.14 | 0.252 | 0.501 | 0.904 | 0.303 | 0.411 |
| | lead (Mg/Kg) | 0.406 | 0.416 | 0.503 | 0.889 | 0.787 | 1.031 |
| | Zinc (Mg/Kg) | 5.495 | 4.763 | 13.865 | 16.041 | 15.792 | 19.225 |

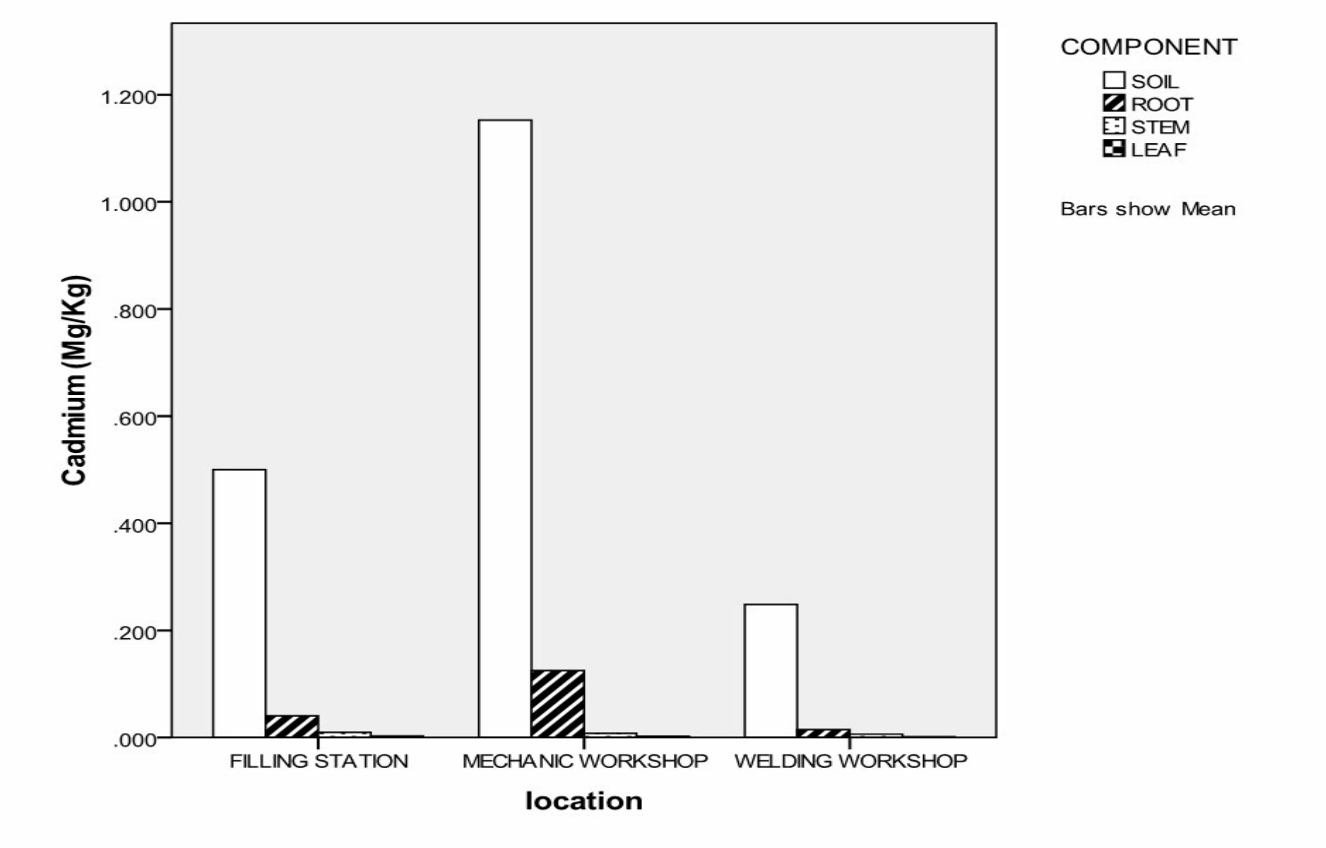


**Fig 1 :** Cadmium distribution in *Talinum triangulare* and soil at filling station, mechanic workshop and welding workshop.

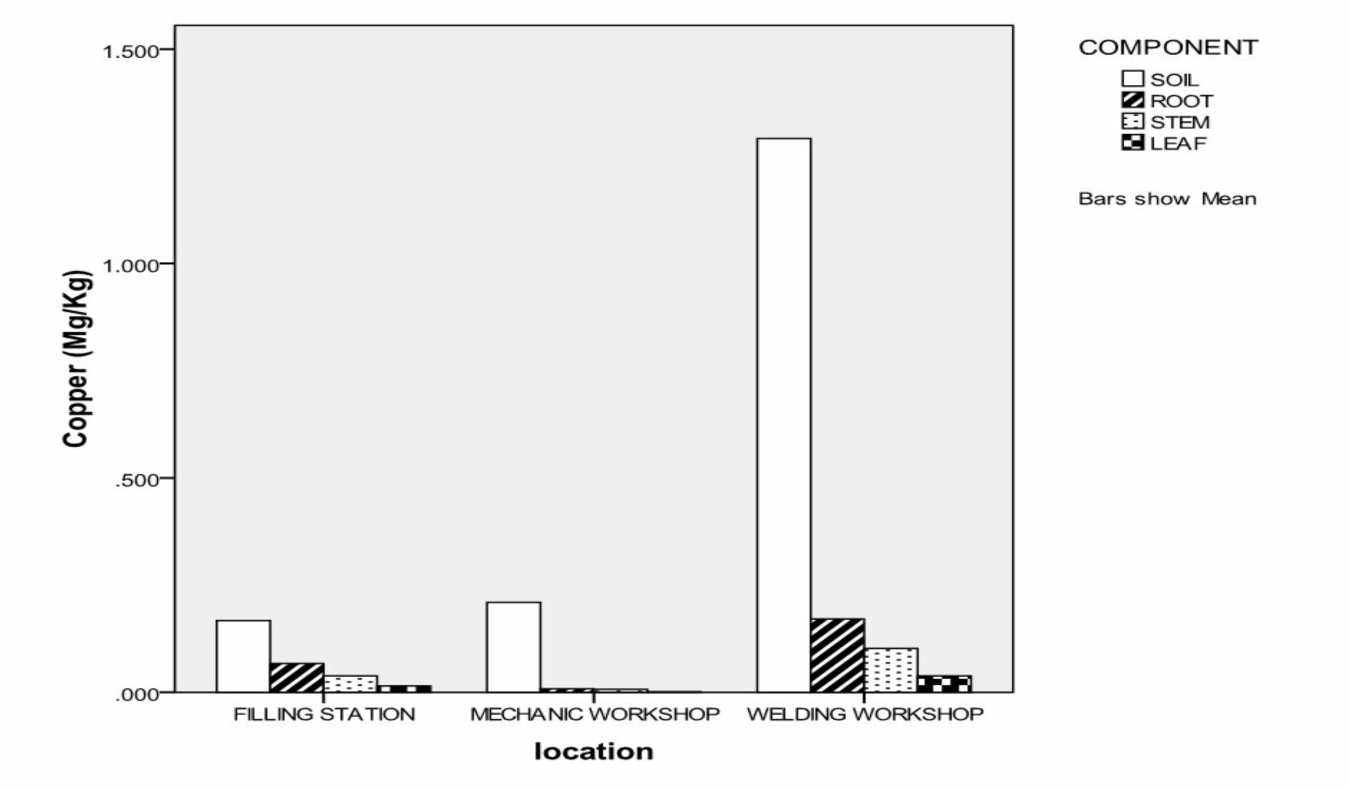


**Fig 2:** Copper distribution in *Talinum triangulare* and soil at filling station, mechanic workshop and welding workshop

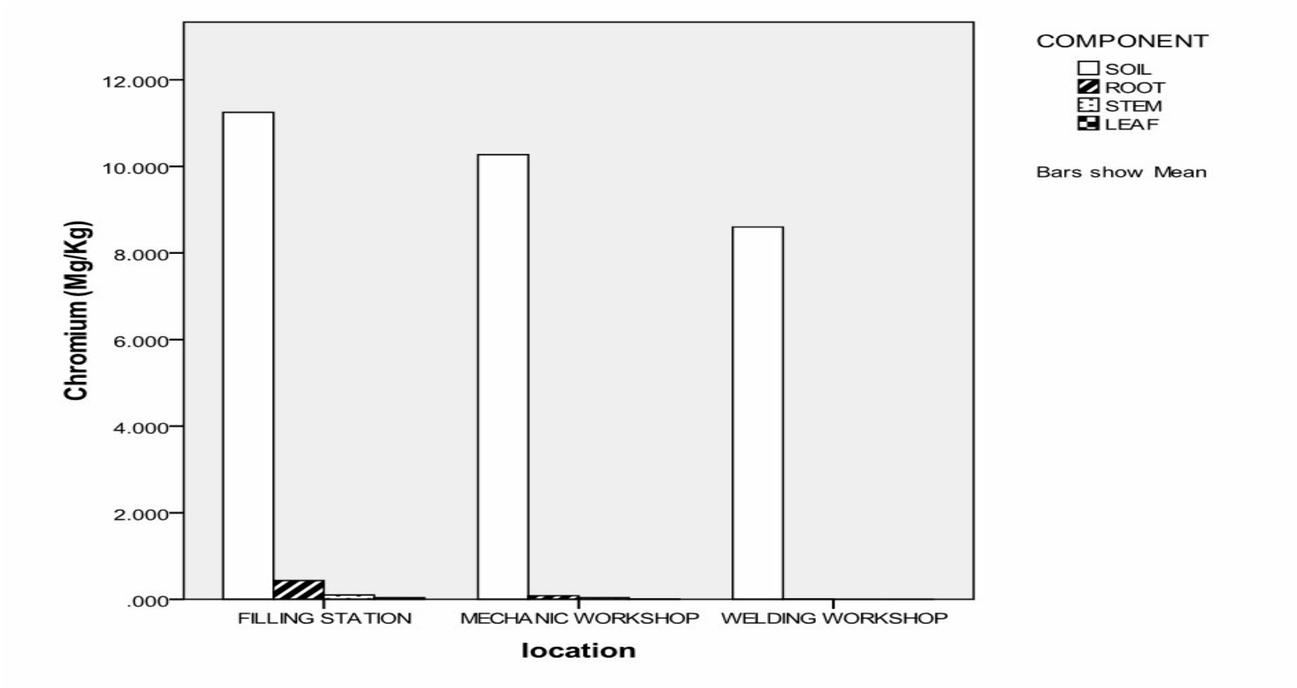


**Fig 3:** Chromium distribution in *Talinum tirangulare* and soil at filling station, mechanic workshop and welding workshop

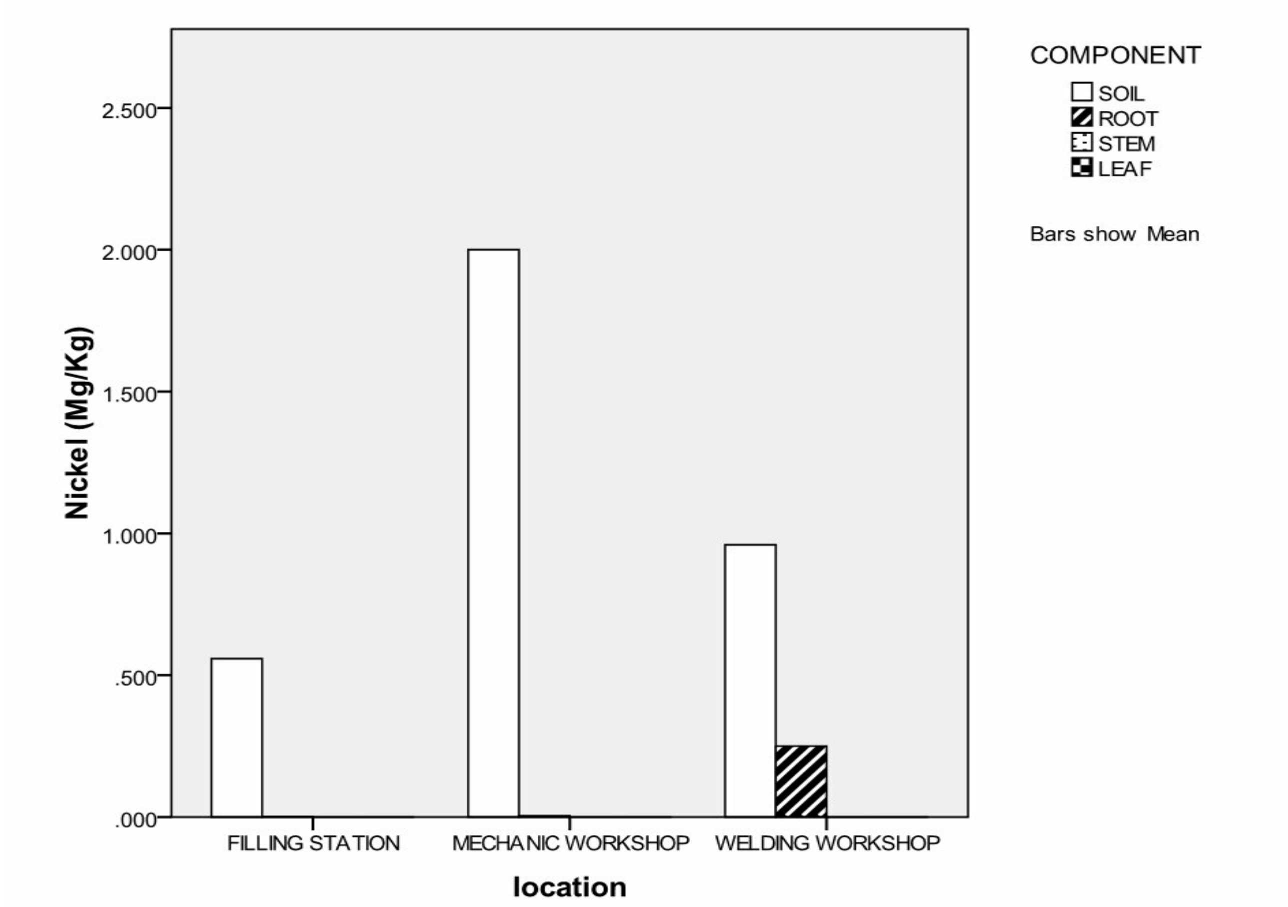


**Fig 4:** Nickel distribution in *Talinum triangulare* and soil at filling station, mechanic workshop and welding workshop

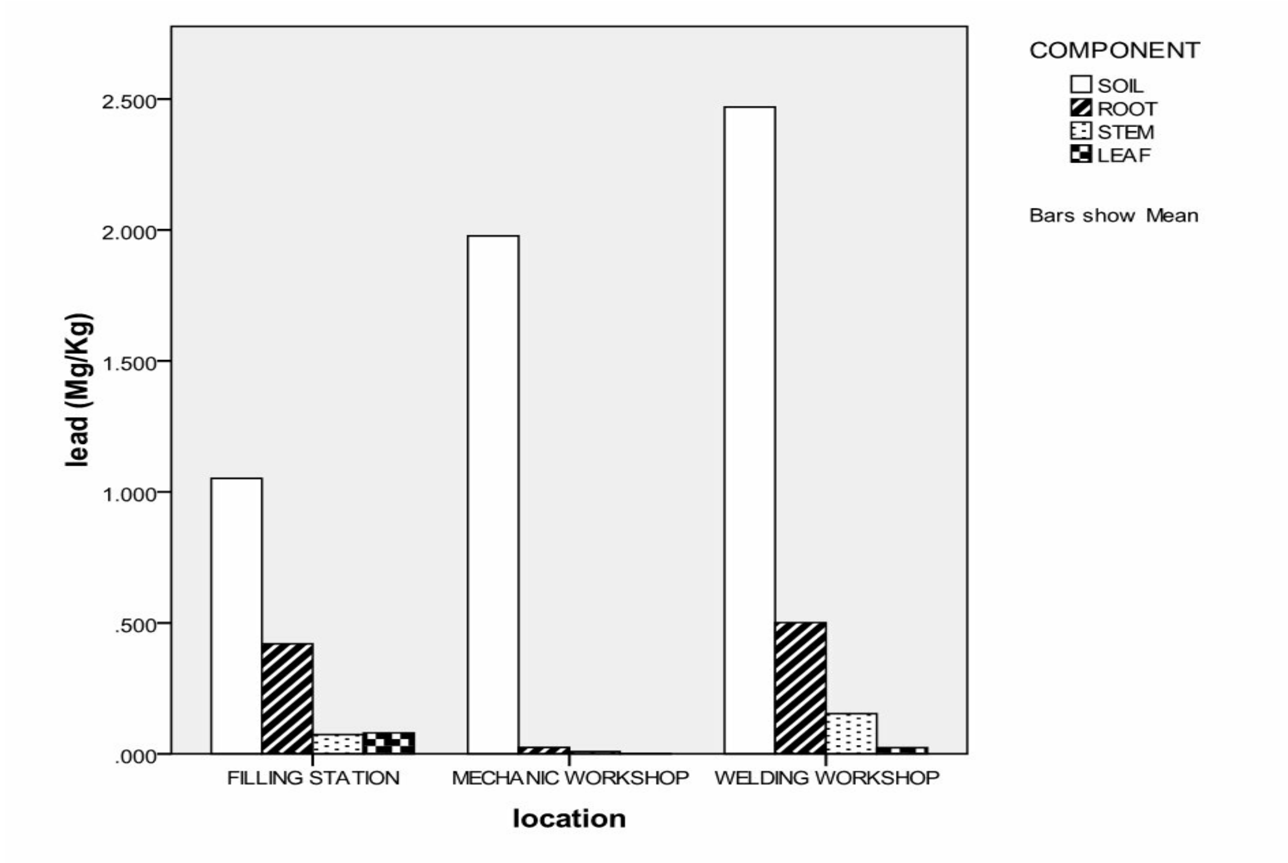


**Fig 5:** Lead distribution in *Talinum triangulare* and soil at filling station, mechanic workshop and welding workshop.

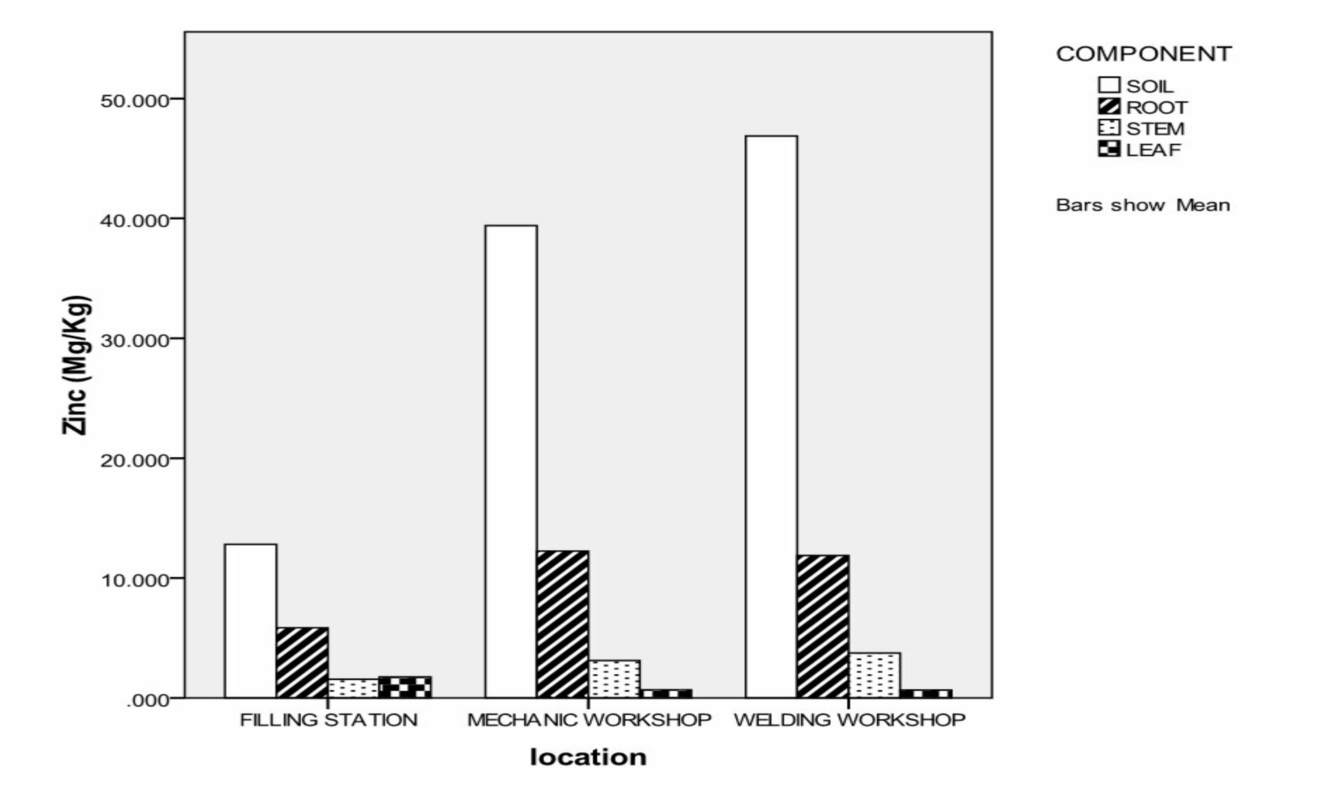


**Fig 6:** Zinc distribution in *Talinum triangulare* and soil at filling station, mechanic workshop and welding workshop.