Comparative Study of the Level of some Heavy Metals in Spinach (*Amaranthus Caudatus*) grown in selected Irrigated and Non- Irrigated Farmland of Kaduna Metropolis.

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ABSTRACT

Analysis of samples of various parts of spinach (stem, root and leaves) collected from different farmlands within Kaduna metropolis (Tudun wada, Rigasa and Unguwan Rimi) was carried out for the assessment of the level of Zn, Cd, Pd, and Mn were determined using bulk scientific model VPG 210 model Atomic Absorption Spectrophotometer (AAS). The concentrations obtained where compared with the 15standards so as to establish the level of their contamination. The level of Zn was highest in the leaves of irrigated tomato (82.54 μg/g) from Ungwan Rimi. The root of spinach from Tudun Wada was also found to be 6.4μg/g Cd. The level of Pb was found to be 5.40 μg/g in the roots of spinach from Unguwan Rimi which prove to toxic and as such poses risk to human health. These results show that consumption of spinach grown from the examined areas in this research might be liable to Pb and Cd toxicity. This study also shows the effect of trace metals and the roles they play physiologically.

Keywords: Spinach, heavy metals, Atomic Absorption Spectrophotometer, Kaduna Metropolis, Nigeria.

INTRODUCTION

Heavy metals are trace metals with a density at least five times that of water. They are stable elements that cannot be metabolized by the body and get passed up in the food chain to human beings. Heavy metals are natural components in the environment but are of concern because they are being added to soil, water and air in increasing amounts. This is due to the rapid growth of population increase urbanization, expansion of industrial activities etc. Some of the heavy metals are essential elements to living organisms, but excessive amounts are generally harmful to plants and animals[1]. The poisoning by heavy metals depends on a great deal on their chemical form, concentration, resident time etc. As a result heavy metal pollution is a serious threat which puts living organisms at risk. Therefore it is necessary from time to time to check the concentration[1] of these heavy metals in the soil, water and food stuffs in order to take preventive measures to avoid poisoning as a result of high concentrations of these metals[2].

Heavy metals are present in agricultural soil at low levels. Due to their accumulative behaviors and toxicity, they have potential hazardous effect not only on the plants but on human health[3].

Today, heavy metals are ubiquitous because of their excessive use in industries. The types of adverse health effects are known to a great extent but, because of the very strange influence of confounding factors, it is very difficult or almost impossible to find thresholds for some outcomes such as impartment of cognitive functions in

children exposed to lead or mercury. Chronic high level intakes have adverse effects on human beings and other animals due to the fact that there is no effective mechanism for their elimination from the body[4]. Metal such as lead, mercury, cadmium and copper are reported to be exceptional toxic[5].

Increasing industrialization has been accompanied by the extraction and distribution of minerals substances from their natural deposits throughout the world[6]. It is known that some heavy metals (Zn, cu, Mn etc) are micronutrients at low concentration. Nevertheless, metals are most often found as contaminants in vegetables. These metals pose a significant health risk to humans, especially when they reach high concentrations in the body. This can be expressed in the inhibition or activation of certain enzymatic processes affecting the productivity from both qualitative and quantitative aspects[7].

The sources of heavy metal pollutants are metal mining, metal smelting, metallurgical industries and metal-using industries, waste disposal, corrosions of metals in use, Agriculture and fossil fuel combustion. Heavy metal contamination affects large areas worldwide. Hot spots of heavy metal pollution are located close to industrial sites, around large cities and in the vicinity of mining and smelting plants. Agricultures in these area faces major problems due to heavy metal transfer into crops and subsequently into the food chain[8].

Cadmium is concentrated particularly in the kidney, the liver, the blood forming organs and the lungs. It most frequently results in kidney damaged (necrotic protein precipitation) and metabolic anomalies caused by enzyme inhibitions. Cadmium is a cumulative poison therefore the danger lies primarily in the regular consumption of food stuffs with low contamination[9].

Lead also affect the brain and causing hyper activity and deficiency in the fine motor functions, thus, it result in damage to the brain. The nervous systems of children are especially sensitive to Lead leading to retardation in growth. It is also cardio-toxic and contributes to cardiomyopathy , disease of the heart muscle leading to the enlargement of the heart[8].

Spinacea oleracia (Spinach) is a flowering plant in the family of Amaranthacease. It is a native to Central and South Western Asia. It is an annual plant (rarely biennial) which grows to the height of up to 30cm. Spinach may survive over winter in temperate regions. The leaves are alternate, simple oval to triangular-based, variable in size from about 2-3cm long and 1-1.5cm broad, with large leaves at the base of the flowering steam. The flowers are inconspicuous, yellow-green 3-4mm across containing several seeds[10].

Spinach is an excellent source of Manganese, Potassium, Calcium and Iron. It is also a very good source of dietary fibre, Copper, protein, phosphorus and Zinc. In addition, it is good sources of omega 3 fatty acids, niacin and selenium[11].

Human may also be exposed to nickel by inhalation, drinking water smoking and eating contaminant food. Up takes of high quantities of nickel can cause cancer, respiratory failure, birth defects allergies and heart failure. Human may also be exposed to nickel by inhalation, drinking water smoking and eating contaminant food. Up takes of high quantities of nickel can cause cancer, respiratory failure, birth defects allergies and heart failure[9].

The aim of this research work is to assed the concentration of heavy metals in the root, stem, leaf of spinach obtained from s elected farmlands of Kaduna metropolis so as to ascertain the most toxic part and comparing the concentrations with that of the FAO/WHO standard.

MATERIALS AND METHODS

Sample Collection and Preparation

The spinach sampless were collected from the three agricultural areas of Kaduna metropolis (Tudun wada, Rigasa and Unguwan Rimi) and carefully packed in clean polyethylene bags. These samples were divided into three sub-samples, the roots, stems and the leaves. The samples were thoroughly washed several times with tap water, followed by distilled water and oven dried in an oven at 105^{o}C.

5g of the ground tomatoes sample was weighed into clean crucibles and placed in the muffle furnace to ash for 4 hours at a temperature of 550^{0}C

The ash was weighed again and digested with 20cm^3 of HNO_3/H_2O_2 (1:2) and filtered into 50 ml volumetric flask and made to mark with distilled water. The trace element (Zn, Pb,Mn and Cd) were determined using bulk scientific model VPG 210 model Atomic Absorption Spectrophotometer (AAS).

RESULTS AND DISCUSSION

The concentration of trace metals in spinach (*Amaranthus caudatus*) from irrigated and non-irrigated farms in Tudun wada, Rigasa and Unguwan Rimi , all within Kaduna metropolis were determined and presented.

Table 1.0: The mean concentration of trace metals in various parts of spinach from irrigated and non-irrigated farms in Tudun wada, Kaduna.

Samples	Irrigated				Non- Irrigated			
Spinach	Elements (µg/g)				Elements (µg/g)			
	Zn	Cd	Pb	Mn	Zn	Cd	Pb	Mn
Leaf	42.7	0.16	ND	10.1	39.0	3.16	ND	15.3
Stem	24.8	0.26	ND	4.29	21.4	0.26	ND	0.21
Root	24.6	6.40	ND	0.16	24.3	1.86	ND	0.36

Table .1.0 shows the concentration of trace elements in various parts of spinach such as leaves, stems and roots grown in irrigated and non irrigated sites of Kaduna metropolis. For the irrigated site of Tudun wada it was established that the leaf for spinach had the highest concentration of 42.75 µg/g for zinc metal while the roots had the highest concentration of Cd of 6.40 µg/g and Pb was also lower in concentration

For Non irrigated site the range for the spinach from Tudun Wada sampling site is 21.41-39.09 µg/g, 0.26-3.16 µg/g , 0.01-3.51 µg/g and 0.21-15.36 µg/g for Zn, Cd, Pb and Mn respectively. The results revealed that irrigated spinach from Tudun Wada had higher concentrations of Zinc than that of the non-irrigated spinach sample. The Zn concentration of the irrigated and non-irrigated spinach from Tudun Wada is within the FAO/WHO, 2001 acceptable limit of 73µg/g. On the other hand, the mean concentration for Pb was very small in the irrigated spinach 3.5 µg/g which is far above the FAO/WHO, 2001 limit of 0.30 µg/g. Most

of the concentrations for Zinc in spinach sample recorded in this research work were higher than 10.38μgg^{-1} as reported by[12]. However, the concentrations of zinc recorded in the present study were almost the same with that reported by *13given as* 24.00μgg^{-1} for zinc in vegetable.

Based on the result obtained in the present study zinc does not pose any threat to the consumers of such spinach in the irrigation site of the Kaduna metropolis.

The statistical test of significance using the student t-test showed significant differences ($p<0.05$) This is depicted in the below figures

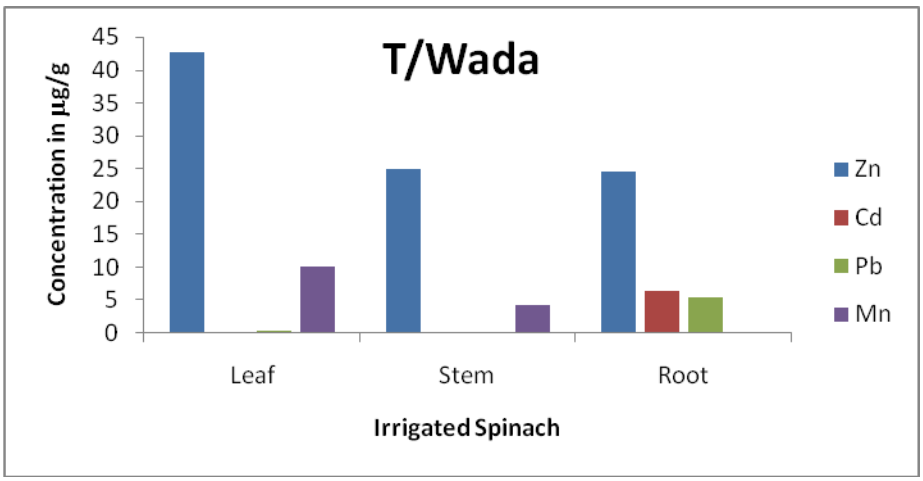

Fig 1: Variation of trace metals in irrigated spinach (leaves, stem and roots) from Tudun Wada.

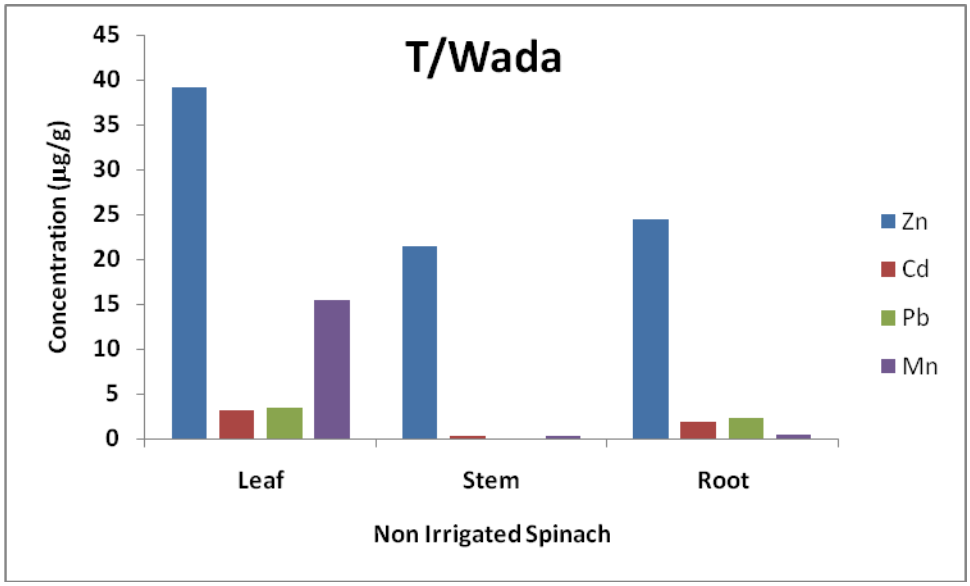

Fig. 2.0: Variation in trace metal concentrations in Spinach leaves, stem and root from Tudun Wada

Table 2.0: The mean concentration of trace metals in various parts of spinach from irrigated and non-irrigated farms in Rigasa, Kaduna.

Samples	Irrigated				Non- Irrigated			
Spinach	Elements (µg/g)				Elements (µg/g)			
	Zn	Cd	Pb	Mn	Zn	Cd	Pb	Mn
Leaf	77.0	0.03	ND	3.70	16.2	0.31	ND	17.7
Stem	27.7	0.85	ND	11.8	46.3	3.11	ND	0.10
Root	20.5	0.28	ND	11.5	18.2	0.56	ND	11.3

Table 2.0 shows the concentration of trace elements in various parts of Spinach such as leaves, stems and roots grown in irrigated and non-irrigated sites of Kaduna metropolis. For the irrigated site of Rigasa it was established that the leaf for spinach had the highest concentration of 77.0µg/g for zinc metal while Mn in the stem the had the highest concentration of 11.8 µg/g. Cd and Pb were not detected.

For Non-irrigated site stem had the highest concentration 46.3µg/g for Zn, then the highest concentration for leaf was obtained as17.7 µg/g for Mn while Cd and pb had the lowest concentration in both stem and root.

From these results, the irrigated tomato from Tudun Wada showed slightly higher concentration of trace metals than the non-irrigated tomato., both the irrigated and non-irrigated tomato samples were found to be within the FAO/WHO range of 73 µg/g. However, the mean concentration values of 11.82µg/g and 8.89 µg/g and for Mn were higher than the results reported by[2] in all the varieties of spinach studied.

The statistical test of significance using the student t-test showed significant differences ($p<0.05$). This is depicted in the below figures.

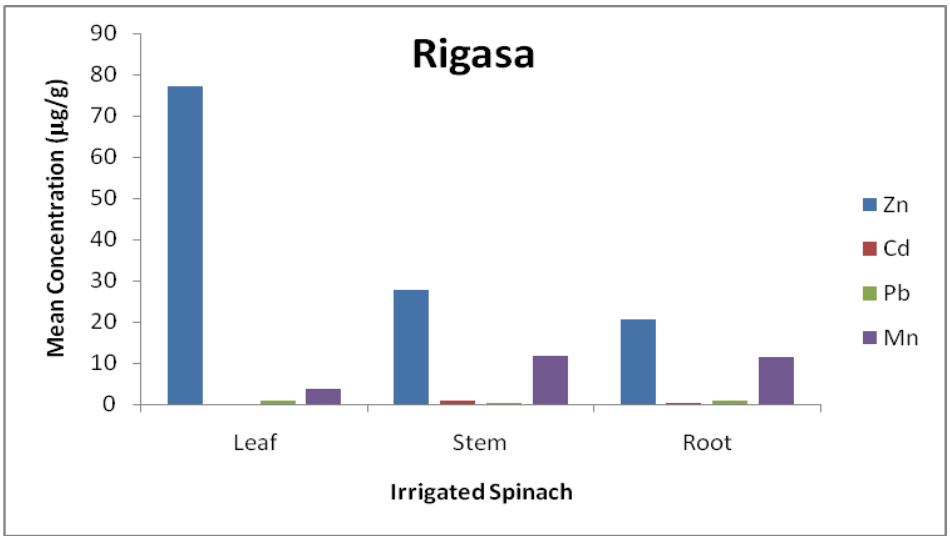

Fig. 3.0: Variation in trace metals in irrigated Spinach (leaves, stem and root) from Rigasa

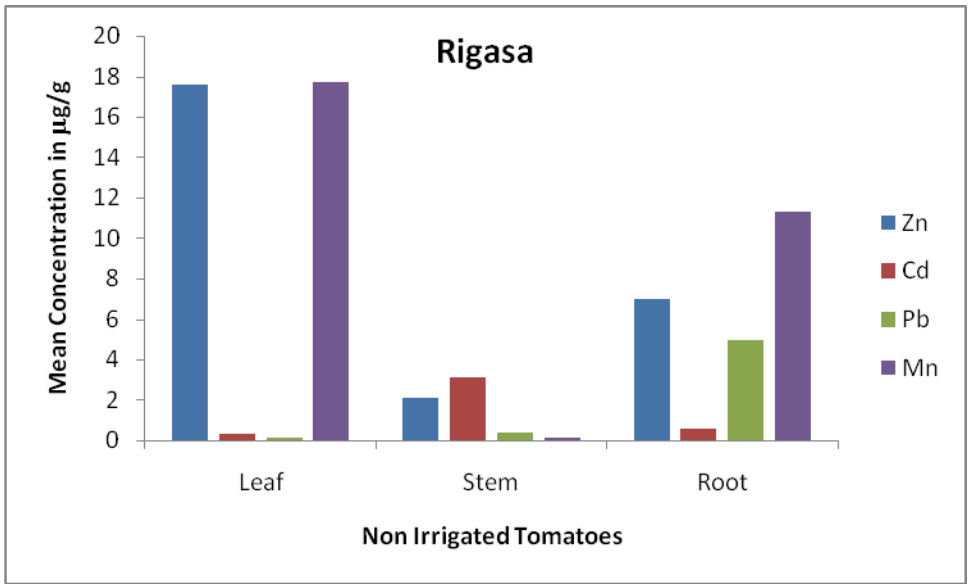

Fig. 4.0 Variation in trace metals in non-irrigated tomato (leaves, stem and root) from Rigasa.

Table 3.0 : The mean concentration of trace metals in various parts of spinach from irrigated and non-irrigated farms in Unguwan Rimi, Kaduna.

Samples	Irrigated				Non- Irrigated			
Spinach	Elements (µg/g)				Elements (µg/g)			
	Zn	Cd	Pb	Mn	Zn	Cd	Pb	Mn
Leaf	76.7	0.42	ND	0.43	8.01	2.97	ND	1.82
Stem	3.99	4.51	ND	0.03	1.66	0.66	ND	1.77
Root	6.14	0.86	ND	20.88	0.70	0.84	ND	0.23

Table 3.0 shows the concentration of trace elements in various parts of Spinach such as leaves, stems and roots grown in irrigated and non-irrigated sites of Unguwan Rimi Kaduna metropolis. For the irrigated site of Rigasa it was established that the leaf for spinach had the highest concentration of 76.7µg/g for zinc metal while stem the had the highest concentration of 4.5 µg/g. Cd. In the root, Mn had 20.8 µg/g which is the highest concentration and Pb was not detected.

For Non irrigated site leaf had the highest concentration 8.0 µg/g for Zn, then the highest concentration for stem was obtained as 1.7 µg/g for Mn, Cd was the highest concentration of 2.9 µg/g in the leaf and pb not detected. These concentrations exceeds those recorded by[14] where they determined the metal contents of plants in vegetable garden sites in Kano metropolis. The Cd levels 2.97 µg/g greatly exceeded the[15] standard of 0.2 µg/g making consumption of these vegetables to be a serious

health risk. In- vitro exposure to lead exposure to Pb and during infancy irreversibly affects development of the nervous system, causing reduced learning disabilities. Cd has estrogenic properties and causes an increased incidence of cancer in mice[16]. Chronic exposure to Cd and Pb is associated with kidney damage in adults[17]. Infants, particularly those born prematurely, have reduced renal function and their developing kidneys are more susceptible to damage caused by Cd and Pb in their diet.

The statistical test of significance using the student t-test showed significant differences ($p<0.05$).This is depicted in the below figures

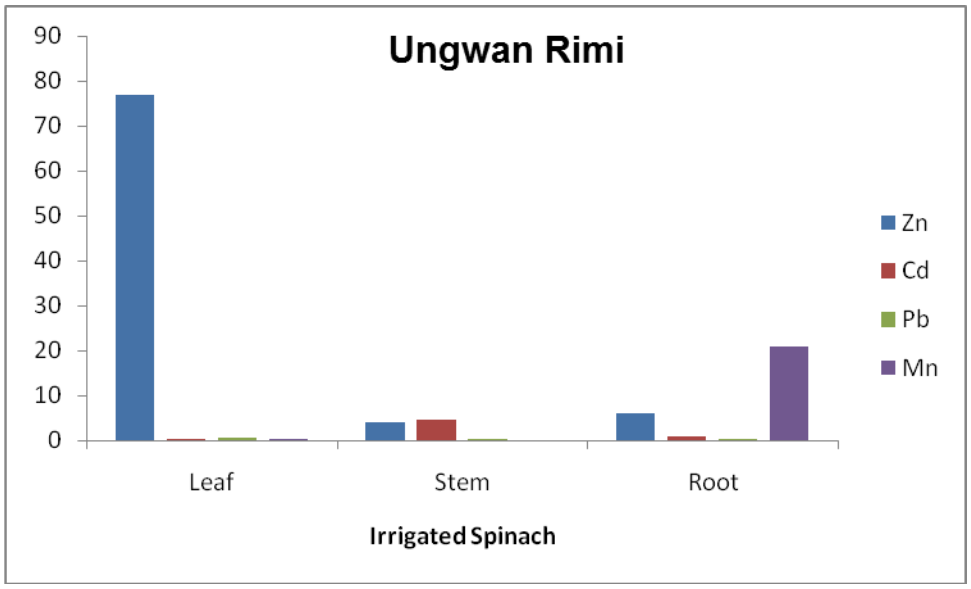

Fig. 3.0: Variation in trace metals in irrigated spinach (leaves, stem and root) from Ungwan Rimi.

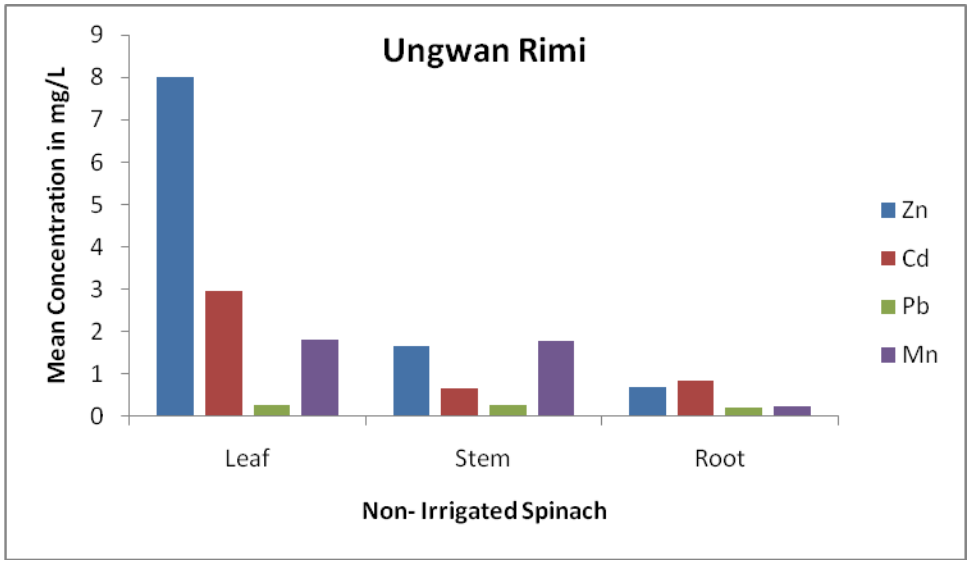

Fig. 5.0: Variation in trace metals in non-irrigated Spinach (leaves, stem and root) from Ungwan Rimi.

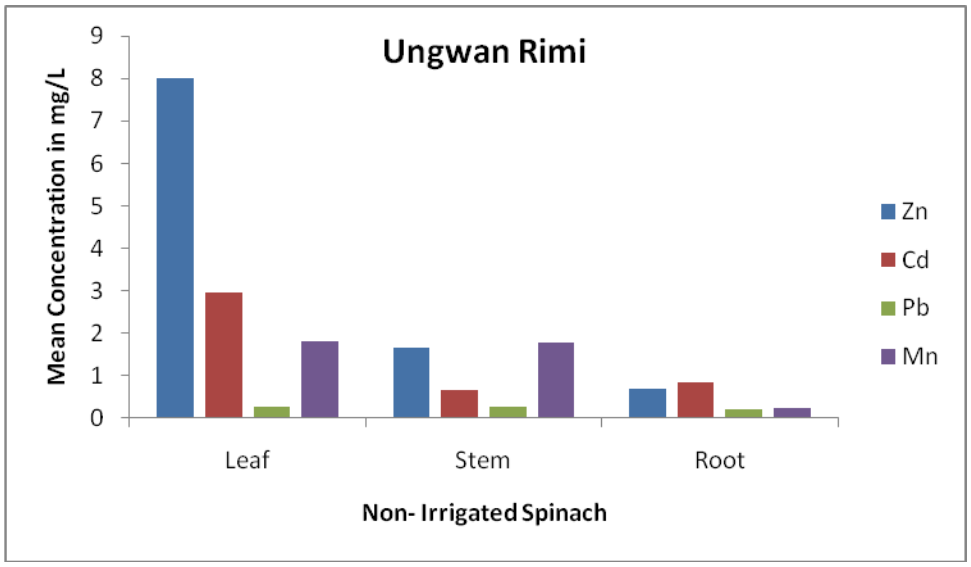

Fig. 6.0: Variation in trace metals in non-irrigated Spinach (leaves, stem and root) from Ungwan Rimi.

CONCLUSIONS

In the present study, the concentration of cadmium, zinc, lead and manganese were determined in irrigated and non-irrigated spinach samples obtained from farmlands of Kaduna Metropolis, Nigeria. The results revealed that the irrigation may be a factor in the contamination of plants in these areas especially Ungwan Rimi and the concentration of zinc, lead and cadmium from some samples were above the recommended limit stipulated by (15) but manganese was found to be within such limit. Therefore, consumption of spinach from the study areas might result to zinc, lead and cadmium toxicity and thereby dangerous to human health.

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