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ANALYSIS ON THE EFFECT OF IRRIGATION ON SELECTED VEGETABLES PLANTED AROUND ZOBE DAM, DUTSIN-MA

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ABSTRACT

Agricultural soil pollution through irrigation with polluted water is one of the major sources of soil pollution and accumulation of heavy metals in soils and plants. The purpose of this study was to determine the concentration of heavy metals (Pb and Cr) in soil and vegetable sample in tomato, spinach and pepper, planted around Zobe Dam, during wet and dry season, using Atomic Absorption Spectrophotometer. Results obtained from this study showed overall concentration of heavy metals (Pb and Cr) respectively, in the range (0.000-2.309) and (0.000-0.204) ppm in the vegetable sample. Generally, the concentration of (Pb) were higher in wet season than the dry season, ranging from (0.000-2.309) ppm and (0.000-0.129) ppm respectively. So also, (Cr) was only detected in one sample P1b (pepper dry season). Whereas, concentration of these metals where not detected in all the soil samples. Similarly, it was found that the concentration of these metals were found to be higher during the wet season with the highest concentration of (Pb) recorded during the wet season. Concentration of (Pb) during the wet season was found to be higher than the WHO recommended value in the vegetable samples.

Keywords: irrigation, lead, chromium, heavy metals, vegetables

INTRODUCTION

Heavy metals pollution is one of the most pressing issues nowadays. Heavy metals are ubiquitous in environment and limits are being exceeded due to both natural and anthropological activities (Harmanescu *et al*., 2011). In agricultural soil and vegetable, heavy metals pollution is one of the most severe ecological problems on a world scale (Ahmad and Goni, 2010). This is because of their toxicity to plant, animal and human beings, and their Non-biodegradability (Zhuang *et al*., 2009). Heavy metals pose potential threats on the environment and can damage human organs through various absorption pathways such as direct ingestion, dermal contact, diet through the soil food chain, inhalation and oral intake (Komarek *et al*., 2008; Lu *et al*., 2011). The food chain contamination is the major pathway of heavy metals exposure for humans (Khan *et al*., 2008).

Untreated wastewater use for agricultural practices is widespread practice in the developing countries (Ensink *et al*., 2002). Generally, heavy metals like cadmium, lead, zinc are toxic at high concentrations (Azam *et al*., 2014). Contamination of vegetables with heavy metals are reported due to irrigation with contaminated water, addition of chemical fertilizer, industrial emissions and transportation etc. (Azam *et al*., 2014).

Factors such as atmospheric deposition, climatic and soil characteristics and irrigation frequency of water affects the extent of heavy metals contamination while processes like adsorption, and precipitation also contribute to the mobility and bioavailability of heavy metals to the extent that it becomes deleterious to plants (Jamil *et al*, 2006).

However, the body requires some of these metals for its function. Metals such as iron, copper and zinc are required by human for proper functioning of the body systems. Over time, heavy metals accumulate n soils and plants and would have a negative influence on physiological activities of plants (e.g. photosynthesis, gaseous exchange and nutrient absorption). Thus, causing reduction in plant growth and yield (Sucio *et al*., 2008). Consequently, excessive accumulation of heavy metals in agricultural soils not only results in environmental contamination, but also elevates heavy metal uptake by crops which also affects food quality and safety (Sucio *et al*., 2008). Also, other sources through which heavy metals are released to the soil include the use pesticides, fertilizer and use of industrial effluents for irrigation (Durvibe *et al*., 2007). In general, heavy metals like Pb have no beneficial effects in humans, and there is no known homeostatic mechanism for it and are considered the most toxic to humans and animals; exposure to them, even at low concentration have adverse effects to health. (Vieira *et al*, 2011).

The amount and variety of waste materials have increased with technological advancement, growing human population and industrial processes (Ogu *et al*., 2014). The disposal of domestic, commercial and industrial garbage in the world is a problem that continues to grow with human civilization (A-Salam, 2009).

Vegetables refer to the fresh edible portion of herbaceous plant roots, stems, leaves or fruits. Vegetables are widely used for culinary purpose and are very important in human diet because of presence of vitamins and minerals salts. They contain water, calcium, iron, sulphur and potash (Sobukola *et al*; 2010). They are also neutralizing agents for acidic substances forming during digestion (Thompson and Kelly 1990). In addition to their high concentration of micronutrients, vegetables provide little dietary energy, making them valuable in energy limited diets. Therefore, fruits and vegetables are very useful for the maintenance of health as a preventive treatment of various diseases (D'mello, 2003). The presence of heavy metals may have negative influence on the quality of vegetables and fruits causing changes to their taste and smell. Environmental pollution has caused the contamination of soil; on the other hand, wastewater irrigation resulted in significant infusion of non-essential elements in agricultural lands (Deribachew *et al*., 2015).

The aim of this project work is to ascertain the level of heavy metals (Pb and Cr) contaminations in the soils and vegetables planted around Zobe Dam Area in Dutsin-Ma. work will cover rainy and dry seasons in order to assess the effect of irrigation on selected vegetables.

MATERIALS AND METHOD

Materials

Study Location

Zobe Dam, reservoir and irrigation area are located between 7° 15’ of northern latitude and 7° 15’ and 7° 35’ of eastern longitude. In the east, the area is delimited by Kuki and Sayaya, in the north by Dan Makubiri and Safana, and in the South by Danmusa and Makera. The area lies between 450 m and 490 m above Mean Sea Level (MSL).

Figure 1: Map of the study area

Plant and Soil Sample Collection

Plant and soil sample were collected on 27th September, 2018 and 28th March, 2019 from three (3) different irrigation farms at different distance. Random sampling method was used to collect the vegetable samples to obtain composite samples. Plants were kept in separate polyethene bags and properly labeled. Soil samples were collected at a depth of 0 – 5 cm from the same point of collecting plant sample. The samples were kept in polyethene bags and labeled properly as shown in Table 1.

Table 1: Sample Identification

SAMPLE ID	NAME	SAMPLE ID	NAME
Pp1a	Pepper rain grown 1	Pp2a	Pepper irrigation 1
Pp1b	Pepper rain grown 2	Pp2b	Pepper irrigation 2
Tm1a	Tomato rain grown 1	Tm2a	Tomato irrigation 1
Tm1b	Tomato rain grown 2	Tm2b	Tomato irrigation 2
Sp1a	Spinach rain grown 1	Sp2a	Spinach irrigation 1
Sp1b	Spinach rain grown 2	Sp2b	Spinach irrigation 2
Sl1a	Soil rain grown 1	Sl2a	Soil irrigation 1
Sl1b	Soil rain grown 2	Sl2b	Soil irrigation 2

Preparation and Preservation

The vegetable sample were washed with deionized to eliminate dust, dirt and possible parasites. The clean vegetable samples were air-dried and later dried at temperature of 65 °C for 72 hrs until constant weight was obtained. All soil samples were ground with a ceramic coated grinder and then sieved. The final samples were kept in labeled containers at ambient temperature before digestion. (Habeeb *et al*., 2011).

Digestion

Digestion of samples was conducted as follows.

Plants Samples Digestion

0.5 g of homogenized powdered vegetables was weighed and transferred into a 50 ml beaker, and 10 ml of acid mixture containing HNO_3: HCl: H_2O_2 in the ratio 8 : 1 : 1 was later added. The mixture was heated at temperature of 120 °C for three (3) hours on electric hot plate. After the digestion, the solution was filtered out into 100 ml volumetric flask and made up to mark with distilled water. Each vegetable samples were digested and analysed in duplicate to confirm precision (Street, 2008).

Digestion of Soil Sample

0.5 g of dried and homogenized sample was transferred into 50 ml beaker. 5 ml of deionized water was added followed by 30 ml mixture of HNO_3 and HCl the ratio 5:1 was later added. The mixture was heated at temperature of 150 °C for 3 hrs, during which a certain amount of deionized water was added until digestion was completed. The digest was transferred into 100 ml volumetric flask and made up to mark with distilled water. Each soil samples were digested and analysed in duplicate to confirm precision (Street, 2008).

RESULT AND DISCUSSION

Analysis of lead and chromium in the soil and selected vegetables; spinach, tomatoes and pepper was carried-out for both raining and irrigation seasons within a period of six months. Results obtained are presented and discussed below.

Distribution of Pb and Cr in Soil Samples

The concentration of Lead and Chromium in soil samples during wet and irrigation seasons are shown in in Table 2. The result shows that, during both the wet and irrigation seasons, concentration of Lead and Chromium were not detected or are below detection limit (BDL).

This indicates that the soils from these farms have no concentration of either Lead or Chromium.

Table 2: Concentration of Pb and Cr in Soil Samples

Sample	Pb con. (ppm)	Cr con. (ppm)
Raining		
SL1a	BDL	BDL
SL1b	BDL	BDL
Irrigation		
SL2a	BDL	BDL
SL2b	BDL	BDL

BDL is below the detectable limit

Levels of Heavy Metals in Vegetable Samples

The concentration of these metals are presented in Tables 3 to 6.

Levels of Heavy Metals in Pepper

The concentration of lead was found to be 0.527 ppm and 2.309 ppm during the wet season and that of chromium was found to be below detectable limit in the first sample and 0.204 ppm in the second sample. Thus, the concentration of Lead in pepper samples during the wet season were found to be above the WHO permissible limit of 0.5 mg/kg. During the irrigation season Lead and Chromium were below detection limit (BDL).

Table 3: Concentration of Pb and Cr in Pepper Samples

Sample	Pb con. (ppm)	Cr con. (ppm)
Raining		
Pp1a	0.527	BDL
Pp1b	2.309	0.204
Irrigation		
Pp2a	BDL	BDL
Pp2b	BDL	BDL
WHO(1999)	**0.5mg/kg**	**1.2mg/kg**

BDL is below the detectable limit

Levels of Heavy Metals in Tomato

Concentration of lead during the raining season in tomato was found to be 0.763 ppm and 1.219 ppm. Therefore, the concentrations of Lead in both samples during the wet season were found to be above the WHO (1999) permissible limit of 0.5 mg/kg. The concentration of chromium in the same season was below the detectable limits in the samples. However, for irrigation season, lead was not detected in in tomato samples. Also, chromium was not detected in samples taken during the irrigation season.

Table 4: Concentration of Pb and Cr in Tomato Samples

Sample	Pb con. (ppm)	Cr con. (ppm)
Raining		
Tm1a	0.763	BDL
Tm1b	1.219	BDL
Irrigation		
Tm2a	BDL	BDL
Tm2b	BDL	BDL
WHO(1999)	**0.5mg/kg**	**1.2mg/kg**

Levels of Heavy Metals in Spinach

In spinach, another vegetable used, the concentrations of Lead were 2.050 ppm and 0.441 pm during the wet season. Chromium was not detected in the samples. In irrigation season, Lead was only detected in one sample and was found to be 0.129 ppm. Chromium was found to be below the detectable limit in spinach during the dry/irrigation season.

The concentration of Lead was found to be higher in one of the sample 2.050 ppm than the WHO (1999) permissible limit 0.5 mg/kg and below the WHO standards 0.441 ppm in the second sample.

Table 5: Concentration of Tomato Samples

Sample	Pb con. (ppm)	Cr con. (ppm)
Raining		
Sp1a	2.050	BDL
Sp1b	0.441	BDL
Irrigation		

Sp2a	0.129	BDL
Sp2b	BDL	BDL
WHO(1999)	**0.5mg/kg**	**1.2mg/kg**

Heavy Metal Concentration in Vegetable Samples

These vegetables, tomato, pepper and spinach were analyzed for Pb and Cr total metals content. The level of heavy metals Pb and Cr in vegetables varies from sample to sample in the same vegetable and from vegetable to vegetable in the same growing season and different season (wet and dry season). Additional sources of these elements for plants are rainfall, atmospheric dust, plant protection agent and fertilizers (Gezahegn, 2013).

From the study, it is revealed that most of the metals were accumulated in the vegetable samples which could be to greater or lesser extent in comparison with to WHO standards. The vegetables are consumed by urban population of the city of Dutsin-Ma and nearby communities, thus indicating possibility of exposing the population to dangerous levels of heavy metals.

Distribution of Chromium in Vegetables

Exposure of humans to Chromium may occur through breathing, drinking, or eating food containing chromium. However, daily uptake of it within a certain range of concentrations by human beings and animals is considered to be essential for carbohydrate and lipid metabolism (Girmaye, 2012). In this study the chromium contents in vegetables samples were obtained to have ranged from 0.204 ppm (in pepper) to BDL (in all the remaining samples), and these results were below the permissible level set by WHO (1999).

Distribution of lead in Vegetables

Results show that the level of Lead in the vegetables studied has a range of 2.309 ppm to 0.763 ppm in wet-season and 2.050 ppm to 0.129 ppm in the irrigation season.

Table 6: Comparison of Heavy Metals concentration in Wet Season

Sample	Conc. Of Pb (ppm)	SAMPLE	Conc. Of Cr (ppm)
Pp1a	0.527	Pp1a	BDL
Pp1b	2.309	Pp1b	0.204
Tm1a	0.763	Tm1a	BDL
Tm1b	1.219	Tm1b	BDL
Sp1a	2.050	Sp1a	BDL
Sp1b	0.441	Sp1b	BDL
Sl1a	BDL	Sl1a	BDL
Sl1b	BDL	Sl1b	BDL
WHO(1999)	**0.5mg/kg**	**WHO(1999)**	**1.2mg/kg**

Table 7: Comparison of Heavy Metals concentration in Dry Season

Sample	Conc. Of Pb (ppm)	SAMPLE	Conc. Of Cr (ppm)
Pp2a	BDL	Pp2a	BDL
Pp2b	BDL	Pp2b	BDL
Tm2a	BDL	Tm2a	BDL
Tm2b	BDL	Tm2b	BDL
Sp2a	0.129	Sp2a	BDL
Sp2b	BDL	Sp2b	BDL
Sl2a	BDL	Sl2a	BDL
Sl2b	BDL	Sl2b	BDL
WHO(1999)	0.5mg/kg	WHO(1999)	1.2mg/kg

Data obtained in this study shows that in both seasons (wet and dry), the concentration of Lead (Pb) were found to be above and below the WHO (1999) permissible limits. Lead is a toxic element that can be harmful to plants, although plants usually show ability to accumulate large amounts of Lead without visible changes in their appearance (Bigdeli and Seilsepour, 2008).

CONCLUSION

As stated earlier, the major purpose of this study was to find out the level of heavy metals in soil, and edible part of the vegetables (spinach, tomato and pepper) Therefore, in this study, the concentrations of some heavy metals (Pb and Cr) in edible vegetables (tomato, pepper and spinach) grown and Zobe dam irrigation site during wet and dry season were investigated to ascertain the effect of irrigation on heavy metals uptake.

Given the importance of vegetables in the food pyramid, their safety is very important from view point of public health as vegetable contamination by heavy metals can lead to bioaccumulation of these toxic and disease causing elements in the body of consumers.

This study showed concentrations of Pb and Cr for soil samples were not detected in the soil within the 5 cm depth used in this study. However, the concentrations of some heavy metals (Pb and Cr) in edible vegetables (tomato, pepper and spinach were found to be in the range of 2.309 ppm to 0.441 ppm (wet season) and 0.129 ppm (dry season) for Pb and Chromium respectively.

The heavy metal (Pb and Cr) concentration in vegetables samples (Spinach, tomato and pepper) from field irrigated with Zobe dam reservoir water were found to be lower in concentration compared to concentrations obtained during wet season.

Thus, it can be concluded from this analysis that, the concentration of Pb And Cr contained in the selected vegetables grown during rainy season is significantly higher compared to that in present in plants grown during irrigation season. This implies that irrigation does not have significant effect on the amount of heavy metals present in the selected vegetable plants within the studied area when compared with rainy season. The higher concentration of Pb and Cr during the wet season could therefore be linked to capillary action and transport system processes which are more prevalent in wet season.

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