

Full Length Research Paper

Nitrate, chlorophyll and zinc quantification in *Manihot esculentum* leaves from Uyo municipal waste dump

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ABSTRACT

The tradition of farming on pieces of land situated around waste dumps for the purpose of harvesting soil nutrients to enhance crop productivity is of great agricultural importance. However constant incineration of waste dumps may not guarantee this assumption. Nitrate, chlorophyll and zinc were quantified in the soil and leaves of *MANIHOT ESCULENTUM* as a life cycle assessment indices to estimate nutrient cycling and impact on productivity. Leaves of *M. ESCULENTUM* were collected from farmland along Uyo waste dump sites, they were washed and shade dried. Chlorophyll concentration in fresh samples was determined spectrophotometrically at 480nm while nitrate and zinc concentrations were determined using atomic absorption spectrophotometer (AAS). The result showed that chlorophyll content was slightly lower in leaf samples from farm land along the dumpsite (17.53 ± 0.09 mg/kg) against the control samples (18.92 ± 0.09 mg/kg). Nitrate content significantly decreased (20.69 ± 0.09 mg/kg) than the control (69.41 ± 0.69 mg/kg). Zinc content of *M. ESCULENTUM* leaves from dumpsite areas showed slight decrease (0.96 ± 0.14 mg/kg) than the control (1.53 ± 0.08 mg/kg). Soil sample analysis showed that nitrate concentration was slightly higher (20.95 ± 0.35 mg/kg) than the control (20.45 ± 0.15 mg/kg). Zinc concentration in the dumpsite soil was 1.18 ± 0.28 mg/kg while the control soil contained 1.55 ± 0.05 mg/kg. Generally, the leaves of *M. ESCULENTUM* showed lower nitrate, chlorophyll and zinc contents against the farmers' assumption and could lead to lower productivity as a result of constant burning.

Keywords: Productivity, incineration, life cycle assessment, waste management and nutrient cycling.

INTRODUCTION

Plant productivity depends on many factors which could be manipulated to enhance targeted interest of individual farmers. However, most farmers seek to enhance productivity through the use of organic and/or inorganic fertilizers. The use of leachate spiked soils or farming on lands located around leachate polluted soil is a common practice that requires further studies. Leachates from active and closed municipal solid waste (MSW) landfills can be a major source of contamination to farmland, groundwater and surface waters (Hancock et al, 1995; Flyhammer, 1997; Ding et al, 2001). Generally, industrial solid waste/sludge is also mixed to municipal solid waste (MSW) and used for landfills, which also potentiate the toxicity of MSW due to the presence of various pollutants. Landfill leachate is generated by excess rainwater

percolating through the waste layers in a landfill (Christensen and Tjell, 1984). The leachate of various hazardous constituents of waste contaminates soil as well as water bodies. Municipal sludge may contain heavy metals and organic pollutants which are potentially harmful to crops and microorganisms in soil. Contaminated crops reduce quality of the feed and food (McLaughlin et al., 1999; Giller et al., 1998; Das et al., 1997; McBride, 1995).

All living organisms require a source of nitrogen, which is necessary for the synthesis of amino acid and other compounds. Generally, plants are able to use either ammonia or soluble nitrate as their sole source of nitrogen. Nitrate itself is innocuous, but nitrite is the toxin. Nitrate is reduced to nitrite by the enzyme nitrate

reductase. This enzyme is found in plants and live plants absorb nitrate with soil fluids and transport it to the site of photosynthesis for reduction to amines for biosynthesis of amino acids and proteins. Nitrate is absorbed when ever plants absorb water and it can be stored for later reduction within the plant tissue and reaches its highest concentrations in stubble and stalk tissues. Effect of toxic metals on human health and their interactions with essential heavy metals may produce serious consequences such as Iron, Lead, Chromium, Nickel, Arsenic and Cadmium are considered suitable for studying the impact of various foods on human health (Abdulla and Chmielnicka, 1990).

Uyo municipal waste landfill contains a variety of pollutants or contaminants due to the heterogeneity and unsorted state of the landfill, so plants, water bodies and the atmosphere serve as direct reservoir for the uptake and dissolution of the different contaminants. This has led to serious imbalance in the ecosystem which include; pollution and contamination of the plants causing alteration in their productivity potential, hence the objective of this study.

MATERIALS AND METHODS

Study Area and Sampling Location

Uyo municipal waste which represents a typical urban disposal center is located at old stadium road off Wellington Bassey Way (Barracks Road) and No 5 Umo Essien Street off obio Imoh Street, both sites locates within Uyo Local Government Area, Akwa Ibom State, Nigeria.

Collection of Samples

The leaves of *Manihot esculenta* Crantz (cassava leaves) were collected from the dumpsite and from No 5 Umo Essien Street, a normal farmland which served as control site. Top soil (0-15cm) samples were also collected from the dumpsites and the farmlands. This research work was carried out during the dry season of the study area in the month of March, 2010. A total of two different cassava leaves and two soil samples were collected from two different locations (one sample per location) at the dumpsites and normal farmlands into pre-cleaned polyethylene Bags.

Extraction of Plant Material and Soil Sample

The cassava leaves were properly washed with distilled water prepared in the Biochemistry laboratory of the University of Uyo, dried in an oven at about 75°C for three days, and pulverized to fine powder using a stainless grinder. Ground cassava leaves were collected

in a labeled 30ml bottle for analysis. The soil samples were oven dried for three days at 75°C, crushed and passed through a 2mm sieve and then collected in a well labeled 30ml bottle for analysis.

Preparation of Soil and Vegetable Samples

For both cassava leaves sample and the soil sample 10g were weighed into a 100ml volumetric flask, and 50ml of Morgan Reagent was added into the flask. The whole set up was allowed to stand for 1 hour 30 minutes and was then filtered. Ten milliliters (10ml) of Morgan Reagent was measured to be used as blank and also 10ml of the filtrate (extracted sample) was measured out for the analysis using UV-spectrophotometer.

Heavy Metal Determination

About 0.5ml of the samples was measured into a round bottom flask and 100ml of distilled water was added. Thereafter HNO₃/HCl in the ratio of 3:1 was added into the sample. The sample was brought to boil using the heating mantle for 1½ hours and allowed to cool down to room temperature. The sample was filtered into a rubber container and made up to 100ml with distilled water. The filtrate was then taken to the UNICAM 939 Atomic Absorption Spectrophotometer (AAS) for the heavy metal (Zinc) determination.

Statistical Analysis

Mean and standard deviation was calculated using SPSS (statistical package for social sciences) software package.

RESULTS

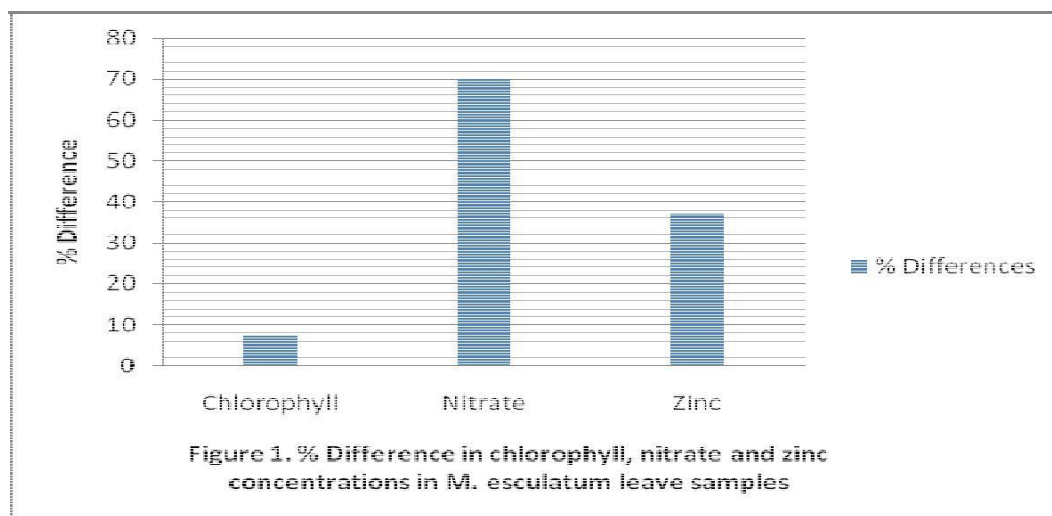
Table 1 shows that nitrate content (20.69 mg/kg) and the zinc content (0.96 mg/kg) in *Manihot esculentum* leaves were significantly lowered when compared with the control value of 69.41 mg/kg and 1.53 mg/kg for both Nitrate and zinc respectively. Table 2 shows the concentration (mg/kg) of the two soil samples that were obtained from the dumpsite and a soil sample that was obtained in a normal farmland as control. Result shows that the nitrate concentration in the dumpsite soil sample 1 (20.95mg/kg) was higher than the control (20.45mg/kg). Zinc concentration in dumpsite soil sample was 1.18mg/kg but lower than the concentration in the control (1.55mg/kg). The Nitrate concentration (mg/kg) in *Manihot esculentum* leaves shown in Table 1 indicates that the dumpsite cassava leaves that were collected about 10 meters from the leachate area had higher nitrate and zinc more than samples collected from 40 meters from the leachate site. The concentration of nitrate and zinc in the farmland soil sample used as control indicates a higher concentration.

Table 1. Nitrate and zinc concentration (mg/kg) in *Manihot esculentum* leaves samples harvested from farmland along Uyo waste dump.

Sample Types	Chlorophyll	Nitrate(NO_3^-) mg/kg	Zinc (Zn) mg/kg
Farmland cassava leaves (control)	18.92±1.09	69.41±3.63	1.53±0.08
Dumpsite cassava leaves	17.53±1.47	20.69±1.70	0.96±0.04

Table 2. Nitrate and zinc concentration in farmland along dumpsite and uncontaminated soil samples.

Sample Types	Nitrate(NO_3^-) mg/kg	Zinc (Zn) mg/kg
Farmland soil sample (control)	20.45±2.15	1.55±1.06
Dumpsite soil sample	20.95±1.32	1.18±0.28



DISCUSSION

Soil samples from waste dumps are undoubtedly a rich source of nitrogen and other essential nutrients necessary for proper growth and development of plants and cash crops in general. The traditional practice of farming along waste dump or along leachate flow may go beyond nutrient harvesting to other unperceived adverse effect by local farmers. Although the interest of farmers in adopting this practice is stemmed on the fact that such soil samples are rich sources of nitrate and other essential minerals. Our result clearly showed that this expectation may not be true as we recorded lower level of nitrate in *M. esculentum* from dumpsites than the samples harvested from the control. This observation may be as a result of the fact that Uyo municipal waste dumpsites are under constant burning or incineration which may account for the destruction of lots of organic nutrients in the waste. The practice of waste incineration is employed by waste management agency of Akwa Ibom state in order to reduce waste load in the dumpsite. This traditional method of waste burning has a lot to do with environmental degradation and nutrient lost. However, in developed countries like USA, waste composting has

been reported by many researchers as a good source of organic manure for agricultural purposes and a means of reducing waste load in our environment. (Jason et al., 2005; Dan, 2013). There was a slight decrease in chlorophyll content of *M. esculentum* leaves compared with those from the control site. This observation may be as a result of depleted nitrate content in the plants. Plant productivity has a direct link with the nitrogen content; therefore any factor that directly or indirectly affects it will consequently affect its consumers and the environment where wastes are dumped. The presence of nitrogen in soil and chlorophyll in plants are directly related. Leaf color can indicate the amount and proportion of chlorophyll in leaves which in turn, are closely related to plant nutrient status (Shigeto and Makoto, 1998). This may be the reason why farmers farm along waste dumps or deliberately packed soil samples to other sites in order to improve the soil nutrient quality for increased plant productivity. Plant productivity is a unique process that depends greatly on the amount of chlorophyll present in the chloroplast. Chlorophyll is the pigment that gives plant their characteristic green color; it plays a unique role in the physiology, productivity and economy of green plants including *Elaeis guineensis*. The quantity of

chlorophyll per unit area is an indication of photosynthetic capacity and productivity of a plant (Otitoju and Onwurah, 2010). Therefore, the amount of chlorophyll in the leaf tissues may be influenced by nutrient availability and environmental stresses such as drought, salinity, crude oil pollution of soil, heat etc. (Palta, 1990; Karacan, 2006 and Onwurah *et al.*, 2007).

Leachates from active and closed municipal solid waste (MSW) landfills can be a major source of contamination to ground and surface waters (Hancock *et al.*, 1995; Flyhammer, 1997; Ding *et al.*, 2001). Generally, industrial solid waste/sludge is also mixed to municipal solid waste (MSW) and used for landfills, which also potentiate the toxicity of MSW due to various pollutants. Landfill leachate is generated by excess rainwater or run-off percolating through the waste layers in a landfill (Christensen and Tjell, 1984). The leachate of various hazardous constituents of waste contaminates soil as well as water bodies; hence crops grown in this area may not be free from contaminants such as heavy metals or other hazardous substances. Municipal sludge may contain heavy metals and organic pollutants which are potentially harmful to crops and microorganisms in soil. Contaminated crops may reduce quality of food produced and consequently may affect the health of consumers. (McLaughlin *et al.*, 1999; Giller *et al.*, 1998; Das *et al.*, 1997; McBride, 1995).

Zinc is essential for the normal growth of plant although elevated concentration of zinc can result in growth inhibition and toxicity symptom. Zinc is also an essential micronutrient for humans, because it activates a large number of enzymes. In particular, zinc has been recognized as a co-factor of superoxide dismutase enzyme, which is involved in protection against oxidative processes (Terres and Navarro, 2001). Zinc is an important element in soil and can affect nutrient value of crops. Zinc deficiency in soil reduces agricultural productivity as also zinc content in agricultural products. It is also an essential micronutrient for healthy functioning of the human body. Though present in tiny amounts, it is critical to life and its deficiency can have a variety of adverse consequences. Thus, both deficiency and excess of essential micronutrients (Zinc, Iron and Chromium) may produce undesirable effects (Konofal *et al.*, 2004; Kocak *et al.*, 2005). In conclusion, the practice of farming on or along dumpsites should be discouraged especially in the country where wastes generated are heterogeneous.

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