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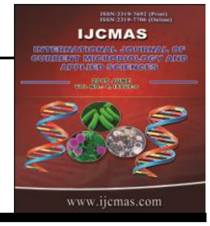

Original Research Article

Heavy metal accumulation from abattoir wastes on soils and some edible vegetables in selected areas in Umuahia metropolis

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A B S T R A C T

This study was aimed at evaluating the total contents of five heavy metals; Fe, Zn, Cd, Pb and Cu in soils and some widely consumed vegetables from farms near abattoirs in Umuahia, Nigeria. Substantial amount of these heavy metals were detected in the vegetables at both abattoirs. Cadmium seemed to have varied with depth as the metal was not found in depth beyond 10cm in one of the abattoirs. However, *Amarathus spinosus* showed good accumulator of Cadmium, lead and copper. This study highlights that both adults and children consuming vegetables grown in abattoir wastes consume substantial amount of these metals. However, the values of these metals were below the recommended maximum tolerable levels proposed by the Joint FAO/WHO Expert Committee on Food Additives. Also an increasing need for further research on the mechanisms of plants survival in heavy metal contaminated soils is advocated.

Keywords

Abattoir,
Waste,
Edible vegetables,
Heavy metal

Introduction

Abattoir wastewater constitutes one of the greatest threats to environmental safety probably because of the presence of mineral constituents (Fadeyibi *et al*. 2011). Wastewater from abattoir contains varying amounts of heavy metals many of which poses serious threat to plants and the ecosystem. Leafy vegetables such as spinach, carrot and cabbage absorb some of these heavy metals when they are irrigated with abattoir effluent; and when in turn consumed by man adversely affects health. It is worth noting that the environmental impact of wastewater irrigation varies from city to city depending on industrialization, type of industry, nature of water distribution and/or the degree of water treatment and dilution. Heavy metals in natural environment are present in various chemical forms and exhibits different actions in term of chemical interactions, mobility, biological availability and potential toxicity (Osu et al 2014).

The consumption of heavy metal contaminated vegetables constitutes risks to both humans and animals (Sajjad et al2009). Vegetables can become contaminated with heavy metals when grown on soils contaminated by vehicular exhaust, industrial activities, abattoir waste and other agricultural activities (Cui et al 2004; Fadeyibi et al 2011; Osu and Ogoko, 2014). However, the level of heavy metals in vegetables and soils and their risk to humans are of great public concern (Xie et al. 2006; Wang et al. 2008; Osu and Ogoko, 2014). According to Iyengar and Nair, (2000) and Turkdogan et al.(2003), the intake of heavy metal-contaminated food can seriously reduce some vital nutrients in the body that are further responsible for decreasing immunological defences, intrauterine growth retardation, decreased psycho-social faculties, disabilities associated with malnutrition and high prevalence of upper gastrointestinal cancer rates.However, Muchuweti et al. (2006) observed that too much accumulation of heavy metals in agricultural soils through wastewater irrigation may in addition to soil contamination, also lead to elevated heavy metal uptake by crops, and thus affecting the quality and safety of food. Also, plants show varying degrees of reaction to the increasing toxic effects of heavy metal concentrations in soil, depending on the sensitivity of plants exposure intensity and chemical constituents. Some plant species are killed while some on the contrary are stimulated by these elements. Some plant species (metallophytes) have developed tolerance towards metals, and others (hyper accumulators) are characterized by the capacity to accumulate high quantities of metals in their tissues.

Similarly, it has been showed that cadmium accumulates mostly in lettuce, spinach, cereal, cabbage, than in tomatoes, corn, or sweet pea, while *Verninia amydalina, Telfera occidendalis,* and *Amarathus spinosus* have been shown to be good accumulators of Lead and Copper (Osu and Ogoko 2014). However, Cadmium and Lead present a risk for human health because they are non-degradable pollutants, having a large spectrum of effects (e.g., nervous or digestive system disturbances and carcinogenic effects), especially in young children (Li et al 2004). In most cases, the main route of exposure is through dietary intake (Calderon et al 2003; Roychowdhury et al2003). This study therefore evaluated the level of heavy metal (Fe, Zn, Cd, Pb and Cu) contamination of soil and selected edible vegetables (*Vernonia amydalina, Telfera occidendalis and Amaranthus spinosus)* which can result from the effects of wastes from abattoirs.

Materials and Methods

Sample collection and preparation

Samples from soil and some edible vegetables were collected from fields around two abattoirs in Umuahia, Abia State Nigeria, in August - September, 2014. The edible vegetables included; *Vernonia amydalina*, *Telfera occidendalis* and *Amaranthus spinosus*. Soil samples were collected at different depth using soil augar and labeled A_1,A_2, A_3 and B_1, B_2 and B_3. A and B represent the sampling sites; Ubakala and Ibekuabattoirs respectively, where 1,2 and 3 represent the different soil depths of 0 – 10 cm , 10- 20 cm and 20 – 30 cm, respectively. Plant samples were labeled a, b and c which represent the edible vegetables; *Vernonia amydalina*, *Telfer aoccidendalis* and *Amaranthus spinosus*, respectively. The soil samples were air dried, ground into fine powder using pestle and mortar and sieved with 2mm mesh. The leaves of the plant samples were rinsed immediately after collection with sterile distilled water to remove any contaminant on the plant surfaces, blotted with tissue paper, and weighed. The samples were also airdried, chopped up, macerated and sieved using 2mm mesh.

Heavy metal analysis for the soil samples

The method of Lokeshwari and Chandrappa, (2006) was adopted in heavy metal analysis. 2 g each of the samples was put into 250 mL glass beaker and digested with 8 mL of aqua regia on a sand bath for 2 hours. After evaporation to dryness, the samples were dissolved with 10 mL of 2 % nitric acid, filtered and then diluted to 50 mL with distilled water. The filtrate was then used for heavy metals analysis using atomic adsorption spectrophotometer UNICAM SOLAAR 32. The soil samples were analyzed for the following heavy metals; Iron (Fe), Zinc (Zn), Cadmium (Cd), Lead (Pb) and Copper (Cu).

Heavy metal analysis for the plant samples

Dry plant samples were wet- ashed using HNO_3: H_2SO_4: $HClO_4$ (10:1:4 v/v), filtered and then dilute to 50 mL with distilled water. The filtrate was then used for heavy metals analysis using atomic adsorption spectrophotometer UNICAM SOLAAR 32. The plant samples were also analyzed for Iron (Fe), Zinc (Zn), Cadmium (Cd), Lead (Pb) and Copper (Cu).

Results and Discussion

Abattoir wastes have led to changes in some soil physiochemical characteristics and heavy metal uptake by vegetables. The change in soil pH is influenced by these wastes, and the soil pH has a great influence on the mobility and bioavailability of heavy metals (Nigam et al. 2001).Probably, continuous deposition of abattoir wastes elevates the level of heavy metals in the soils and in edible vegetables. Accumulation of heavy metal by vegetables is a cause of serious concern due to the potential public health impacts (Bi et al. 2006; Cui et al., 2005).

In Table 1, it was found that the concentration of metals in the soils from sampling site A analysis ranged from 0.5 - 2.9 mg/kg, Pb; 0.06 - 1.9 mg/kg, Cd; 16.9 - 254.5 mg/kg, Fe; 0.05 - 1.7 mg/kg, Zn; 2.3–14.1mg/kg, Cu.Data from sampling site B showed that the concentration of metals ranged from 0.001 - 1.1mg/kg, Pb; 13.7–86.3mg/kg, Fe; 0.2–4.1mg/kg, Zn; 1.7- 17.4 mg/kg, Cu; (Table 2).Cadmium seemed to have varied with depth as the metal was not found in depth beyond 10cm in this sampling site. The normal lead content in soil is 18 - 36 mg kg-1 as it is specified in the European legislation. Copper remains in the area where it was distributed because it forms compounds to the organic matter of the soil. If the content exceeds 20 mg kg-1, the effect of copper upon the plant is toxic (Lato et al., 2012).

The result also showed that the heavy metal concentrations in the edible vegetables varied greatly in Table 3 and Table 4. Lead was higher (0.34 mg/kg) in *Amarathus spinosus* for soil B and lower (0.03 mg/kg) for soil A. Copper was higher (9.01 mg/kg) in *Amarathus spinosus* for soil B and lower (4.4 mg/kg) in *Telfera occidendalis* for soil B. No trace of Nickel was detected in all the plant samples. However, the result obtained in this study was lower than that obtained by Lato et al. 2012 and Osu and Ogoko, 2014 and thus reveals that the heavy metal concentration in plant samples could vary with sampling sites and human activities.Sharma et al. (2007) observed lower metal concentrations, detected in the plants grown in wastewater-irrigated soils in India.

Table.1 Concentrations of heavy metals (mg/L) in soils from Abattoir A

Parameters	0 -10 cm	10 – 20 cm	20 -30 cm
Fe	254.5 ± 1.02	213.0 ± 1.01	16.91 ± 0.2
Zn	1.68 ± 0.002	0.18 ± 0.004	0.05 ± 0.003
Cd	1.9 ± 0.002	0.3 ± 0.002	0.06 ± 0.1
Pb	2.9 ± 0.002	2.9 ± 0.003	0.5 ± 0.01
Cu	14.1 ± 0.002	5.9 ± 0.02	2.3 ± 0.003

Table.2 Concentrations of heavy metals (mg/L) in soils from Abattoir B

Parameters	0 -10 cm	10 – 20 cm	20 -30 cm
Fe	86.3 ± 1.1	13.7 ± 0.76	17.6 ± 0.1
Zn	4.1 ± 0.01	0.76 ± 0.001	0.2 ± 0.01
Cd	2.4 ± 0.1	-	-
Pb	0.5 ± 0.001	1.1 ± 0.001	0.001 ± 0.01
Cu	17.4 ± 07	1.8 ± 0.13	1.7 ± 0.2

Table.3 Concentrations of heavy metals (mg/kg) in edible vegetables from Abattoir A

Parameters	A	b	c
Fe	6.4	10.1	5.84
Zn	0.02	0.2	0.04
Cd	0.5	0.2	0.81
Pb	0.2	0.3	0.03
Cu	6.2	7.6	8.64

Where; a = *Vernoniaamydalina; b = Telferaoccidendalis*and c = *Amaranthusspinosus*

Table.4 Concentrations of heavy metals (mg/kg) in edible vegetables from Abattoir B

Parameters	A	b	c
Fe	14.5	5.45	8.7
Zn	0.8	1.3	0.04
Cd	0.5	0.87	0.76
Pb	0.18	0.07	0.34
Cu	9.1	4.4	9.01

Where; a = *Vernoniaamydalina; b = Telferaoccidendalis*and c = *Amaranthusspinosus*

The authors observed increased in the contamination of Cd, Pb, and Ni in edible portion of vegetables from treated and untreated wastewater for irrigation, thus causing long term potential health risk.

However, Arora et al (2008) advocated constant monitoring of heavy metals from effluents and sewage, in vegetables and in other food materials as measures to prevent excessive build-up of heavy metals in the food chain.The heavy metal concentrations in the vegetables, particularly, Cu, Pb, and Zn were lower generally lower.

Amarathus spinosus showed good accumulator of Cadmium, lead and copper. The values of heavy metals in the studied vegetables are of great concern to consumers eating vegetable products obtained on these lands. In general the results indicated that none of the plant species were identified as hyper accumulator because all species accumulated Pb, Cu, Zn, Fe and Cd less than 1000 mg/kg. The results of study showed an increasing need for further research on the mechanisms of plants survival in heavy metal contaminated soils. Adherence to standards for heavy metal contamination of soil and irrigation water may not ensure safe food as shown by some researcher. However, studies are needed to determine the growth performance, biomass production and metal accumulation of these vegetables in heavy metal contaminated soils for their better management and conservation.Assessment of the health risk of any chemical contaminant is important to evaluate the level of exposure by measuring thecourses of exposure of a contaminant to the target organisms. There are various possible exposure pathways of contaminants to humans but the food chain is one of the most important pathways. Edible vegetables were shown to be contaminated with heavy metals and the consumption of such vegetables could cause risk to human health. However, in the study area, the vegetables produced are eitherconsumed directly or sold in the local urban markets thus a concern for consumers.

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