 J Life Sci, 3(2): 93-96 (2011)

Assessment of Heavy Metals in Some Edible and Fodder Plants from Mazimbu Village, Morogoro, Tanzania

Richard A. Giliba[1], Emmanuel K. Boon[2], Canisius J. Kayombo[1], Leonard I. Chirenje[3], Emmanuel B. Musamba[4], Almas M. Kashindye[1] and James R. Mushi[5]

[1]Forestry Training Institute, Tanzania
Email: richiea78@yahoo.com
[2]Vrije University Brussels, Belgium [3]Hillcrest College, Zimbabwe, [4]Ministry of Natural Resources and Tourism, [5]Sokoine University of Agriculture, Tanzania

KEYWORDS Heavy Metals. Sewage. Sludge. Fodder Plants. Edible Plants. Pollution

ABSTRACT This paper presents findings on the concentration of different heavy metals namely copper, zinc, lead manganese and lead in edible and fodder plants growing in sewage areas. Plants with potential of being used as food and/or fodder were identified and their respective foliage samples were collected. Thereafter their respective green weights were recorded. The foliage samples were subsequently sun-dried to constant weights, ground and analyzed in the laboratory for their chemical compositions and concentrations. Results indicate that the samples recorded varied concentration of heavy metals, with high copper, zinc and manganese in most of the samples *viz.* in kapok leaf, lucaena leaf, sesban leaf, cocoyam leaf, manihot leaf. The highest recorded concentrations of heavy metals do not exceed published critical and phytotoxic levels. However, continuous exposure to these metals might bring about bioaccumulation and thus harmful health effects on the population.

1. INTRODUCTION

The dramatic increase in public awareness and concern about the state of the global and local environments, which has occurred in recent decades, has been accompanied and partially prompted by an ever-growing body of evidence on the extent to which pollution has caused severe environmental degradation (Alloway 1990). The introduction of harmful substances into the environment has been shown to have many adverse effects on human health, agricultural productivity and natural ecosystems. Amazingly, the global environmental systems have been able to remain resilient despite the precarious and heavy burden of pollutants imposed upon them (Yap 2009). This resilience of the environment has promoted an unsustainable rate of pollution from human activities and there is an urgent need for change in behavior. It is therefore imperative to create as much awareness as for people to appreciate the extent of pollution, its causes, and the substances involved, their biological and environmental effects and method of controlling and rectifying pollution (Odero 1998).

The pollution of soil aquatic ecosystems by pollutants such as toxic heavy metals has recently been taken as a central theme in developing countries. Semu (1997) highlights that the improvement of the quality human life due to the advances in science and technology on many occasions has been parallel with the deterioration in the quality of the environment mainly the dispersion of hazardous substances such as heavy metals to the environment. The source of heavy metals pollutants in urban environments may be divided into pollutants from metal and chemical industries, automobiles and municipal wastes and their incinerating plants (Komai 1981; Kabata-Pendias 2001).

A common perception is that vegetables fed by surface and or wastewater, fertilized with sludge and grown in air polluted areas bear a health risk for consumer (Mlozi 1996). Depending on the origin and composition, sewage sludge may contain variable amounts of toxic metals in addition to beneficial nutrients. Conway and Pretty (1991) stated that one of the major sources of land pollution is sewage sludge. Long-term application of sludge resulted in accumulation of heavy metals including Cadmium, Copper, Zinc, Mercury, Nickel, and Manganese in soils and absorption of the metals by plants (Semu 1997; Chiras 2001). The most serious environmental and health risks are noted in the use of largely untreated effluent and wastewater for irrigation. In the study area some households grow edibles and fodders for human and animals respectively around the sewage areas taking the advantage of untreated effluent as the fertilizers. To date, there is relatively scanty information on environmental dynamics and health implications of heavy metals in plants grown in sewage areas as a result of population increase and poor disposal techniques. This study aims to fill in this knowledge gap by assessing the occurrence of heavy metals in edible and fodder plants growing in sewage areas.

2. MATERIAL AND METHODS

2.1 Materials

For the present study, three species of trees *viz.* Sesban *(Sesbania sesban),* Leucaen *(Lucaena leucosiphala*, Kapok *(Ceiba pentandra)*; three species of edible plants *viz.* Cocoyam *(Colocasia esculenta),* Sweet potato (*Ipomea batatus*) Mpira (*Manihot goetzea*); two species of sedges *viz.*Round cyperus (*Cyperus rotundus*), Papyrus (Cyperus papyrus) and one species of grass *viz.* Elephant grass (*Pennisetum purpureum*). The samples were collected from different points at random of the two oxidation ponds of Mazimbu campus. Eight samples of each species were collected. Five heavy metals *viz.,* cadmium, lead, copper, manganese, and zinc were taken up for analysis in the present study.

2.1.1 Study Area

Solomon Mahlangu Campus (SMC)-Mazimbu is one of the four campuses of Sokoine University of Agriculture. It is located on northern suburbs of Morogoro municipality at the end of Mazimbu road, about 5km from Municipal center at latitudes 37° 17' E and 37° 42' E and longitudes 6° 45' S and 7° 00' S. The elevation of the area ranges from 500-600m above sea level. The climate of Morogoro can generally be described as sub-humid tropical climate. Most in the district experience bimodal rainfall pattern characterized by two rainfall peaks in a year with a definite dry season separating the short and long rains (Kaaya et al. 1994). The average annual rainfall is 890mm but this amount may increase slightly with altitude. The dry season is between June and October and temperatures range between 24ºC (in December) and 20ºC (in July). History shows that the onset of both rains and their distribution are irregular and unreliable. The soil moisture regime (SMR) in the area is thus ustic except where there are local effects of flooding and water logging (Kaaya et al. 1994).

2.2 Methods

2.2.1 Data Collection

Plants with the potential of being used as food and/or fodder were identified and their respective foliage samples were collected. Thereafter their respective green weights were taken. The foliage samples were sun-dried to constant weights, ground and analyzed in the laboratory for their chemical compositions and concentrations of five metals with potential for health risk these are; Copper (Cu), Zinc (Zn), Manganese (Mn), Lead (Pb), and Cadmium (Cd).

2.2.2 Data Analysis

The ground samples were qualitatively (contents) and quantitatively (concentrations) analyzed for heavy metals Cu, Zn, Mn, Pb, and Cd in the laboratory. The 1g of each finely ground plant sample was weighed into a digestion tube. To each of the digestion tubes 5ml of 68% HNO_3 was added using a measuring cylinder. The mixtures were left to stand over night. The digestion tubes containing the mixtures were then placed in a digestion block, temperature was set at 125^0C and the sample digested for one hour. The samples were allowed to cool and 5ml of 30% H_2O_2 was added to each mixture and heated to about 70^0C on the digestion block until the reaction stopped. The addition of 5ml 30% H_20_2 to each tube was repeated until the digests turned colourless. The digests were further heated on the digestion block at a temperature of 180^0C, almost to dryness. The digestion tubes were finally removed from the digestion block and allowed to cool. A measure of 10ml 10% HNO_3 was added to each digestion tube and the mixture transferred into a 50-ml volumetric flask and filled to the mark using distilled water (Dey et al. 1999). The solution was then subjected to atomic absorption Spectrophotometry (Perkin Elmer 3110). The sample preparation procedure was followed as described by Dey et al. (1999). Eight replicates of each of the samples were used to confirm quantitative estimation of the elements and the mean values were taken into consideration. The standard deviation (SD) of each set results were evaluated.

3. RESULTS

Table 1 presents the concentration of copper (Cu), zinc (Zn), lead (Pb), manganese (Mn) and

Table 1: Concentration of heavy metals in some fodders, edibles and grass collected from the study area. All values are in mg/Kg dry weight, Values after ± sign are standard deviations (SD)

Plants	*Cu*	*Zn*	*Pb*	*Mn*	*Cd*
Fodder					
Ceiba pentandra	16.42±0.2	7.45±0.26	0.60±0.05	1.64±0.79	0.5 ±0.065
Sesbania sesban	8.75±0.25	16.75±0.21	0.10±0.02	25.22±0.15	0.10±0.01
Leuceana leucosiphala	7.80±0.16	12.62±0.18	0.10±0.02	1.92±0.03	0.15±0.055
Edible					
Colocasia esculenta	4.05±0.12	9.69±0.09	0.20±0.061	27.49±0.25	0.10±0.05
Manihot goetzea	7.00±0.19	40.16±0.35	0.40±0.04	27.55±0.27	0.21±0.06
Ipomea batatus	6.70±0.15	13.56±0.12	0.40±0.06	3.05±0.034	0.20±0.02
Grass					
Pennisetum purpureum	2.30±0.51	7.46±0.12	0.20±0.04	3.53±0.05	0.30±0.07
Cyperus rotundus	2.00±0.04	10.95±0.30	0.40±0.02	1.29±0.01	0.10±0.01
Cyperus papyrus	0.90±0.02	9.75±0.021	0.20±0.011	5.17±0.03	0.12±0.012

cadmium (Cd) in different species of trees, edible plants, sedges and grass. The highest concentration of zinc was recorded in *Manihot goetzea* leaf and *Sesbania sesban* leaf (40.16mg and 16.75mg/Kg dry weight respectively). High manganese was recorded in *Manihot goetzea* and *Colocasia esculenta* (27.55mg/Kg and 27.49mg/Kg dry weight respectively) where in other samples, the concentration varied between 1.29 to 25.22mg/Kg dry weight. Copper was recorded in various concentrations which ranged between 0.9 to 16mg/Kg dry weight. The highest concentration of it was recorded in *Ceiba pentandra* leaf, *Sesbania sesban* leaf and *Leuceana leucosiphala* leaf (16.42mg, 8.75mg, and 7.80mg/Kg dry weight respectively). Similarly, Lead was recorded in various concentrations in all the samples .*Ceiba pentandra* leaf, *Ipomea batatus* leaf and *Manihot goetzea* leaf recorded high concentration of Lead in them (0.6mg, 0.4mg and 0.4/Kg dry weight respectively). High Cadmium was recorded in *Ceiba pentandra* leaf *Pennisetum purpureum*, *Ipomea batatus* leaf and *Manihot goetzea* leaf (0.5mg, 0.3mg, 0.2mg and 0.2mg/Kg dry weight respectively).

4. DISCUSSION

The present study gives possible exposure to toxic metals like copper, zinc, manganese, lead and cadmium in fodder plants (trees, grass) and edible plants (tubers). The observations suggest that the trees and grasses, though contain all the heavy metals examined in various concentrations, their quantity is not high, especially in the case of copper, zinc and manganese in trees. The highest recorded concentrations of zinc, copper and manganese do not exceed published/ universally acceptable critical and phytotoxic levels. Jarvis (1981) reported that 30mgCu/kg, 50mgMn/kg in plant tissue are the limit for most plants, above which toxicity may be observed and if it is taken above this level by human and animals via food chain is hazardous. The highest concentration of zinc in *Ceiba pentandra* can be considered as low when compared to the normal content of 500-1000mg/kg above which harm to human and animals can occur (King and Morris 1992). The concentration of cadmium in all the samples varied between 0.1 to 0.5mg/Kg dry weight. This indicates that the amount is well below the concentration of 35mg/kg proposed by USEPA (1993). This is possibly due to the fixation of soluble lead to unavailable form by the crystal structure of soils.

Furthermore, the concentrations of copper, zinc, lead and cadmium in the samples of edible plants are below the published critical and phytotoxic levels. Mynard and Hchmith (1997) suggested critical concentrations for Cabbage and Lettuce to be 10 and 15mgCu/kg, respectively, compared with the published critical tissue concentration of 7.5mgPb/kg and 50mgZn/kg. Gardener (1995) also recommended a maximum concentration of cadmium in spinach as 0.5mg/kg dry matter. Even though the concentrations are well within the tolerable limit for a human being, long exposure to these metals might bring about bioaccumulation and thus harmful effects on the population. For example lead occurs naturally in soil in relatively low concentrations, but through the addition of industrial lead, for instance lead particles and chips from paints, automobile emission from leaded fuel and similar other sources, the range can go up to 500ppm to over 3000ppm. Chakraborty et al. (2004) observed that soil near heavily traveled roadways is typically 30 to 2000 ppm higher in lead content than soil in a neutral area. Thus, it is an issue of concern that a good number of fodder and edible plants examined in the present study were found to contain lead in them. The authentic worry lies with the children, where the elevated lead in their blood may not show any symptoms, or may show a progression of non- specific symptoms (Zimmermann et al. 2006).

5. CONCLUSION

This study presents a preliminary observation on concentrations of few heavy metals in some common fodder and edible plants consumed by human and animals of Mazimbu village. The study showed presence of heavy metals in quantities that are within the tolerable limit for a human being. However, long exposure to these metals might bring about bioaccumulation and become harmful to the health of the human population.

6. RECOMMENDATION

Owing to long-term effects of sludge-borne heavy metals to fodder, vegetables, crops and soil due to accumulation effects, long-term experiments on heavy metals accumulations are recommended.

ACKNOWLEGMENT

Authors are grateful to the Head, Department of Animal Science, Sokoine University of Agriculture for providing laboratory facilities.

REFERENCES

Alloway BJ 1990. *Heavy Metals in Soils*. New York: John Wiley and Sons Inc.

Chakraborty R, Dey S, Dkhar PS, Thabah CR, Myrboh B, Ghosh D, Sharma DK 2004. Determination of few heavy metals in some vegetables from north-eastern region of India in relation to human health. *Poll Res*, 23: 537-542.

Chiras DD 2001. *Environmental Science-Creating A Sustainable Future*. New York: Jones and Bartlett.

Conway GR, Pretty JN 1991. *Unwelcome Harvest: Agriculture and Pollution.* London: Earthscan Publications Ltd.

Dey S, Stafford R, DebRoy MK, Bhattacharjee CR, Khating DT, Bhattacharjee PC, Dkhar PS 1999. Metal toxicity and trace elementdeficiency in some wild animals from North-east India, as revealed by cellular, bio-inorganic and behavioural studies. *Curr Sci*, 77: 276-280.

Gardiner DT, Miller RW, Badamchian B, Azzari AS, Sisson DR 1995. Effects of repeated sewage sludge applications on plant accumulation of heavy metals. *Agriculture, Ecosystems and Environment,* 55: 1-6

Jarvis SC, Whitehead DC 1981. The influence of some soil and plant factors on the concentration of copper in perennial ryegrass. *Plant and Soil,* 60: 275-286.

Kaaya AK, Msanya BM, Mrema JP 1994. Soils and land evaluation of part of the Sokoine University of Agriculture Farm Tanzania, for some crops under rained conditions. *African Study Monographs*, 15: 97-118.

Kabata-Pendias A, Pendias H 2001. *Trace Elements in Soils and Plants.* 3rd Edition. Boca Raton: CRC Press.

King LD, Morris HD 1992. Land disposal of liquid sewage sludge. The effect on soil, pH, Mn, and growth and chemical composition of rye (*Secale cereale* L.). *Journal of Environ Qual,* 1: 425-439.

Komai Y 1981. Heavy metal contamination in urban soils. *Journal of Environmental Pollution Control,* 13: 911-915.

Mlozi MR 1996. Urban agriculture in Dar es Salaam: Its contribution to solving the economic crisis and the damage it does to the environment. *Development Southern Africa,* 13: 47-65.

Maynard DN, Hochmuth GJ 1997. *Knott's Handbook for Vegetable Growers*. New York: John Wiley and Sons Inc.

Odero DR 1998. *Heavy Metal Pollution in and Around Nairobi River, at Ngara and Gikomba Due to Influx of Metal Wastes from Cottage Industries in the Municipality.* MSc. Thesis Unpublished. Morogoro: Sokoine University of Agriculture, Tanzania.

Semu E 1997. *Soil and Water Pollution. Sources, Impacts and Abatement.* Morogoro: Sokoine University of Agriculture, Department of Soil Science.

USEPA 1993. Standards for use or disposal of sewage sludge. *Feel Reg*, 58: 9248-9415.

Yap DW, Adezrian J, Khairiah J, Ismail BS, Ahmad-Mahir R 2009. The uptake of heavy metals by paddy plants (*Oryza sativa)* in Kota Marudu, Sabah, Malaysia *Journal of Agric and Environ Sci*, 6: 16-19.

Zimmermann MB, Mathayya S, Moretti D, Kurpad A, Hurrell RF 2006. Iron fortification reduces blood lead levels in children in Bangalore, India. *Pediatrics*, 17: 2014-2021.