RESEARCH ARTICLE

Phytoaccumulation of Heavy metals in Contaminated Soil using Makoy (*Solenum nigrum* L.) and Spinach (*Spinacia oleracea* L.) plant

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ABSTRACT

It is a common practice for farmers in India to use soils in municipal waste dump sites as fertile soil for the cultivation of a variety of leafy vegetables and the soils are also used as 'compost' by farmers without regards for the probable health hazards the heavy metal contents of such soils may purpose. This was the case of formers using the deserted dumpsite soil at Baxibandh municipal waste for their livelihood. It was concern that prompted the determination of heavy metals in the soil and control planting on Sheila Dhar Institute of Soil Science farm and that of the Makoy (*Solenum nigrum* L.) plant used to inactivate metals in dump soil. The concentration of heavy metal in the edible part of Spinach vegetable from the dump site and control: Pb (12.4-1.2 mg kg^{-1}); Cd (0.65-0.26 mg kg^{-1}) Zn (44.8-24.6 mg kg^{-1}); Cu (24.2-11.8 mg kg^{-1}) and Cr (0.08-0.04mg kg^{-1}), respectively. The concentration of heavy metals in Makoy (*Solenumnigrum* L.) plant is Pb (45.6mg kg^{-1}); Cd (1.44 mg kg^{-1}) Zn (92.6mg kg^{-1}); Cu (28.8 mg kg^{-1}) and Cr (0.81mg kg^{-1}) in Buxibandh dumpsite soil. The levels of heavy metals in the dumpsite soil and the soil after harvesting the makoy (*Solenum nigrum* L.) plant are Pb (116.4 -50.64mg kg^{-1}); Cd (3.26-1.86 mg kg^{-1}) Cr (2.24-1.72mg kg^{-1}); Zn (184.4-108.6 mg kg^{-1}) and Cu (58.2-24.24mg kg^{-1}), respectively. The spinach species from the dump soil accumulates more heavy metals than that of the control. The level of heavy metals in dump soil decreases rapidly after harvesting the makoy (*Solenum nigrum* L.) plant.

Key words: Heavy metals, vegetable crop plants, dumpsite, Phytoaccumulation.

INTRODUCTION

Heavy metals element in municipal solid waste are gasified during incineration process and then concentrated in ash particle mainly in the form of metals oxides, which are packed in silicate crystal lattices. Generally, MSW fly ash may be detoxified by removing or recovering toxic metals before being reused as concentration materials e.g., cement, concrete, ceramics and glass (Karl *et al*., 2003). Industrialization of the developing countries in Asia of rapid economic growth has created serious problem of waste disposal due to rapid urbanization (ISWA and UNEP 2002). Management of municipal solid wastes is posing a great face to India and other developing countries (Garg and Kaushik, 2005). The total annual generation of MSW in USA in 2003 is 236 million tons per year, which is 50% higher than MSW generated in 1980 (www.epa.gov/msw/msw99.htm.US EPA.2003), New Delhi is the capital of India in 136 kg/person/years. Municipal solid wastes contain many toxic element and there compound caused various ill effect on human health and environment, if their proper management and practice are not available (Kaviraj Sharma 2003), Bhatacharya and Chattopadhyay, 2004). Disposal of municipal solid waste and household hazardous wastes including batteries, paints residues ,ash treated woods and electronic wastes increase the heavy metals in soil (Aleggha,2009).The accumulation of heavy metal ions by root systems is a key function in terrestrial plant, which exhibit extensive ramification through soil. Distribution of heavy metals in plant body depends upon availability and concentration of heavy metals as well as particular plant species and its population (Punz and Seighardt, 1973). Phytoremediation is a general term used to describe various mechanisms by which living plants after the chemical composition of the soil matrix in which they are growing. Essentially, it is the use of green plant to clean-up contaminated soils, sediments, or water. Phytoremediation is considered an innovative, economical, and environmentally compatible solution for remediating some of heavy metal in contamination sites (Cumminghan *et al*, 1997). Several of these plants is Tomato, Indian mustered, Sudan grass, sunflowers, and lemon-scented Geranium. This means that they are able to uptake large quantities of heavy metals and continue to thrive while storing these heavy metals in its plant tissue (Davies, 1983). Heavy metals absorption is governed by soil characteristics such as pH and organic matter content. Thus, high levels of heavy metals in the soil do not always indicate similar high concentration in plants. The extent of heavy metals and toxic level will depended on the plant and heavy metal species under observation (Alloway, 1996). Vegetable are rich source of vitamins, minerals, and fibers, and also have beneficial anti-oxidative effects. However, intake of heavy metal-contaminated vegetable may pose a risk to the human health. This is because, heavy metals have ability to accumulate in living organisms and at elevated levels they can be toxic. It has been reported that prolonged consumption of unsafe concentration of heavy metals through foodstuffs may lead to the chromic accumulation of the metals in kidney and liver of humans causing disruption of numerous biochemical processes , leading to cardiovascular, nervous, kidney and bone diseases (Trichoulous, 1997). The objective of this study, therefore, was to evaluate the contamination of heavy metals in the dump soil and investigate the potentials of Makoy (*Solenumnigrum L.*) plant to reduce the concentration of heavy metals from the contaminated soil.

MATERIALS AND METHODS

Baxibandh dumping site was the main dumping site all the manufacturing industries and city municipal solid waste along this site. The abandoned dumpsite becomes a common place for farmers to cultivate a variety of crops. This is because it is generally believed that the native fertility of the soil from waste dump sites is high. The area sampled was divided into four quadrants. The top soils (0-15 cm) were taken from each of the quadrants. Makoy (*Solenumnigrum L.*) seeds were also planted the soil sample were collected. Spinach seeds were also planted randomly in four different quadrants in Sheila Dhar Institute of Soil Science and harvested after four weeks. Spinach and Makoy samples were collected from each quadrant in a diagonal basis following.

Di-ethyltriaminepenta acetic acid (DTPA) solution {1.97g (0.05M) DTPA powder, 13.3ml (0.1M) Tri-ethanol amine and 1.47g (0.01M) $CaCl_2$ were dissolved in distilled water made up to 1 liter after adjusting the pH to 7.3} was prepared (Lindsay and Norvell, 1978) to extract the available heavy metals in soil samples. Five gram of soil was shaken with 20ml of the above reagent for 2 hr. The clean filtrate was used for the estimation of Heavy metals. One gram of ground plant material was taken in a 100 ml beaker and 15 ml of tri-acid mixture (HNO_3, conc. H_2SO_4 and $HClO_4$ in 5:1:1 ratio) was added. The content was heated on hot plate at low heat (80^0C) for 30 minutes and the volume was reduced to about 5 ml, until a transparent solution was obtained (Allen, *et al*., 1986). After cooling, 20 ml distilled water was added to the beaker and the content was filtered through Whitman number 42 in to a 100 ml volumetric flask and the volume was made up with distilled water. The extract was analyzed directly with the help of Atomic Absorption spectrophotometer Perkin Elemar make modle ANALYST-100 at National Botanical Research Institute (NBRI), Lucknow. (Li *et al.*, 1995).

RESULTS AND DISCUSSION

The heavy metals content of the vegetable tissue is present in Table 1.The transfer ratio of the heavy metals in vegetable in Fig. 1, and the metal Content of dump soil before and after planting Makoy (*Solenumnigrum L.*) is presented in Table. 2, respectively.

Table 1: : Heavy metal content (ppm) in the vegetables.

Heavy Metal	Edible Part of Spinach from the Baxibandh Dumpsite (mg kg^{-1})	Edible Part of Spinach from the SDI Farm (Control) (mg kg^{-1})	Makoy (*Solenumnigrum L.*) Plant (mg kg^{-1})	Indian standard (Awashthi 2000)(mg kg^{-1})
BP	12.4	1.2	45.6	2.5
Cr	0.08	.04	0.21	20.0
Cu	24.2	16.8	28.8	30.0
Fe	92.6	45.8	80.4	-
Zn	44.8	24.6	92.6	50

Table 2: Heavy metal content (mg kg^{-1}) on the soil

Heavy metal	Concentration Of metals in the dump soil before planting Makoy(mg kg^{-1})	Concentration Of metals in the dump soil after planting Makoy (mg kg^{-1})	Indian standard (Awashthi 2000) (mg kg^{-1})
BP	116.4	50.64	250-500
Cr	2.24	1.72	-
Cu	58.2	24.24	135-270
Fe	216.8	120.40	-
Zn	184.4	108.6	300-600

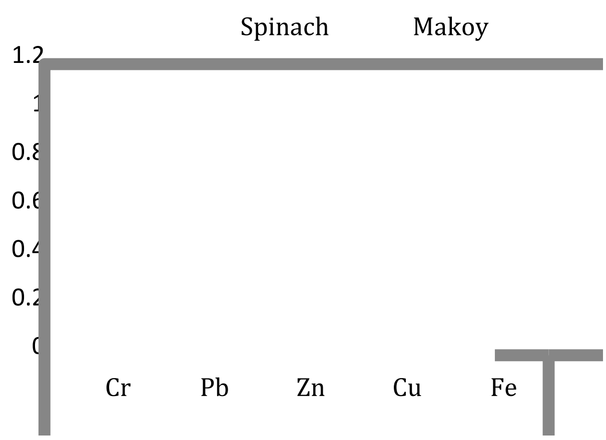

Fig.1. Trans factor ratio in Spinach and Makoy (*Solenumnigrum L.*) plant.

The Makoy (*Solenumnigrum L.*) accumulates more metals then the Spinach from the dump soil as well as the control from the S.D.I farmland. The result shows that vegetables harvested in soils of the refuse dump site presented higher levels of the metals when compared to that from the control site (Table 1). This means that the level of these metals in dump soil is significantly higher than that of farm land (Oyelola *et al.*, 2009). (Odukoya *et al.*, 2001). Schnoor *et al.* (1995) reported that plant grown on soils possessing enhanced metal concentration has increased heavy metals ion content. The depth of time that the soils were exposed to the contaminations affected the levels of concentrations; also the uptake of metal ion has been shown to be influenced by the metal species and plant parts (Uste and Mench, 1992).The transfer ratio (Fig. 1) is the level of metal of the metal in the vegetable as a fraction of the soil total in the dump soil.

The values of transfer factor obtained, show that the uptake of each metal differs from one plant to another. Spinach has lower transfer ratio with the exception of

Fe, which is greater than that of makoy. It was observed that the Spinach has more affinity for Fe than makoy (*SolenumnigrumL.*). The rations obtained for Makoy (*Solenumnigrum L.*) were particularly high. This shows the potential of *Solenumnigrum L.* plant for hyperaccumulater. With increasing metal load in dump soils (Table 2), where these vegetables are grown, there is a greater tendency for their bio-accumulation. Heavy metals are not biodegradable and therefore can accumulate in human vital organs and lead to progressive toxic effect if consumed with food that has concentrations of heavy metals above the permissible levels (Demirezen and Aksoy 2006).

Heavy metal content of the soils

The result show that soils from the dumpsites before and after harvesting Makoy (*Solenumnigrum L.*) differ significantly ($P > 0.05$) in their total metals content as shown in Fig.1 below. The level of metals after harvesting makoy (*Solenumnigrum L.*) plant reduced considerable for Zn, Pb and Cu. This indicates the remarkable ability of makoy (*Solenumnigrum L.*) plant absorbed accumulate high concentration of these three metals. Addition of MSS to agriculture soils is a management practice that can be exploited to replace synthetic fertilizers. However, potential bioaccumulation and mobility of heavy metals from MSS into growing plants could increase the potential transfer of heavy metals through crops to animals (feed crops) and humans (food crops) (Temmerman,2003). Tomato and Solenumnigrum L. crop has been shown to have an exceptionally high tolerance for heavy metals (Baker *et al*, 2000).

CONCLUSION AND RECOMMENDATION

The result of this work show that soils in refuse dump sites are high in heavy metal contents and that plants that grow in these sites bio-accumulate heavy metals than those in normal agricultural soils. It was also observed that plants differ in their ability to up-take metals. An enabling act advising and enforcing the non-use of refuse dump sites for farming is desirable. This will be keeping, in check, possible excessive consumption of these metals by people. If the consumption of these metals through plant source is not carefully regulated, it may lead accumulation in people with attendant health hazards. Makoy (*Solenumnigrum L.*) plant was able to extract different concentrations of heavy metals from the soils. In view of this Makoy (*Solenunigrum L.*), plant can be used to clean up dump soil by formers because dump soils has been founded some heavy metals present in another soil, they can be used as compost or agricultural purpose .It is therefore, recommended that dump soil should not be used for agricultural purpose until after a cleaning process with metal hyper-accumulation plants, which must not be consumed by people or animals after harvesting.

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