Current World Enviroment Vol. **2**(2), 229-232 (2007)

Heavy metal uptake by vegetable crop *Lagenaria siceraria* (bottle gourd)

P. SESHABALA[1], P. CHANDRASEKHAR REDDY[2], SYEDA AZEEM UNNISA[3] and K. MUKKANTI[4]

[1-4]Centre for Environment, IST, Jawaharlal Nehru Technological University, Kukatpally - 500 085 (India).

(Received: October 18, 2007; Accepted: December 14, 2007)

ABSTRACT

Pot experiments where conducted to study the uptake of heavy metals in vegetable crop by *Lagenaria siceraria (bottle gourd)*, especially nickel and lead the most toxic elements from a human health point of view. The analysis results revealed that uptake of Ni and Pb by *bottle gourd* was above the prescribed concentration.

Key words: Vegetable crop, *Lagenaria siceraria,* heavy metal, uptake.

INTRODUCTION

The most urgent need today is to increase the production of nutritious food in a sustainable manner and improve nutritional security, while conserving the natural resource base. Vegetables are the vital sources of minerals, vitamins and dietary fibers play an important role in supplying nutrition to human health. Vegetables require comparatively lesser quantities of agro-inputs to grow[1].

Large areas of agricultural soils are contaminated by heavy metals like Pd, Cr, Ni, Hg and Zn. Elevated heavy metal concentrations in the soil can leads to enhanced crop uptake. Excessive metals in human nutrition can be toxic and can cause acute and chronic diseases[2]. At higher concentrations, they interfere with metabolic processes and inhibit growth[3]. Additional potential sources of heavy metals in field locations in urban and peri-urban areas include irrigation water contaminated by sewage and industrial effluent leading to contaminated soils and vegetables[5]. Other sources can include unsafe or excess application of (sometimes banned) pesticides, fungicides and fertilizers such as sewage sludge [5].

MATERIAL AND METHODS

Soil analysis

Top garden soil from JNTU campus was taken and was air dried, sieved to (<2mm), and thoroughly mixed. Soil analysis was done by analyzing the physico - chemical parameters such as moisture content, texture of soil, pH, organic matter and heavy metals like nickel and lead.

Plant material

Bottle gourd (Lagenaria siceraria) seeds were collected from the village area of Khammam district, AP, which are of hybrid variety, belongs to Cucurbitaceae family.

Sowing and soil treatments

Pot culture experiments were conducted using soil spiked with nickel sulphate and lead nitrate solutions. The final concentrations of Ni and Pb added in soil were 500 mg kg^{-1} each respectively, and for comparison an unamended (control) was

taken. Nickel and lead solutions were uniformly mixed with air –dried soil, kept for 2 weeks to stabilize and filled in pots. Three seeds were sown in the soil to germinate. Out of them only one uniform plant was allowed to grow in each pot. Pots were placed in net house shaded with transparent polythene sheet, to protect from rainwater leaching. Plants were grown under natural light and ambient temperature in order to keep all plants under conditions as similar as possible. Fertilizers or soil amendments were not added to enhance growth or metal uptake.

Plant growth and harvesting

For growth studies individual plants were grown under similar conditions and at set time intervals two plants for 500 mg kg^{-1} concentration and interval i.e., 30days were harvested from the two replicate pots, without damaging the roots. Maximum recoverable portion of roots were procured and plants were rinsed in distilled water to remove dust and soil mineral particles. The total plant was oven dried at 85 °C for 36 hrs and weighed. Shoot and root length in cm and dry biomass in gram of different plants parts (leaves, stem, and roots) were taken for each treatment. All the calculations for uptake and extraction of nickel and lead were done on dry weight basis by using bioconcentration factor (BCF).

Table 1: Physical and Chemical properties of the studied soil

Soil property	Concentration
pH	6.1
Organic matter (%)	1.62
Organic carbon (%)	0.95
Moisture content (%)	2.4
Nickel (mg kg^{-1})	1.8
Lead (mg kg^{-1})	15.63

Plant mass analysis

Dried samples were homogenized using a motor and pestle before analysis. The samples were digested in acidic mixture of HNO_3, and heavy metal analysis was done in duplicate by atomic absorption spectrophotometer (AAS)[6].

RESULTS AND DISCUSSION

For the present study physico-chemical parameters were analyzed for soil and heavy metals treated plant samples in duplicates to assess the uptake of nickel and lead in *bottle gourd* which is shown in Table 1 and 2.

The pH of the soil samples measured averaged 6.1, which is slightly acidic. Soil pH generally plays an important role in metal bioavailability, toxicity and leaching capability to surrounding areas especially in summer times. Heavy metals are mostly more soluble and leach out in acidic pH. This makes them also less bioavailability to plants since they are easily washed away during rains. Soil pH of 6.1 indicates that heavy

Table 2: Heavy metal uptake by total plant (root, leaves, stem) at given treatment (mg kg^{-1}) from soil on 30th day

Soil and plant species	Concentrationof Ni and Pb added in soil(mg kg^{-1})		Concentration of Ni and Pb uptake by plant (mg kg^{-1})	
	Ni	Pb	Ni	Pb
Soil sample	500	500	-	-
Control *(Bottle gourd)*	BDL	BDL	BDL	BDL
Treated Lagenaria siceraria (Bottle gourd)	-	-	-	-
Replicate 1	-	-	135.4	142.2
Replicate 2	-	-	141.2	145.0
Average	-	-	137.0	144.0

BDL: Below detectable limits.

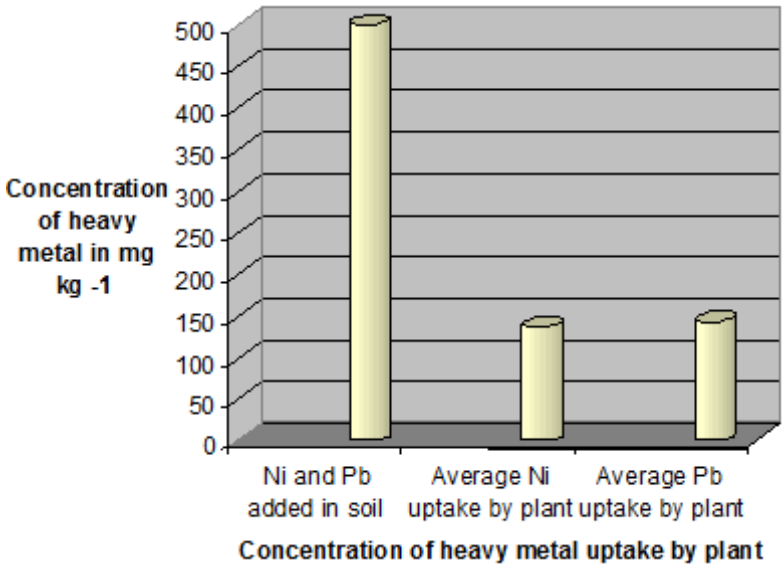
metals may remain in the soil for a long time exposed to plants that come into contact with them[7].

The organic matter content of the studied soil was 1.62%. Organic matter (OM) is usually the organic fraction of decomposed plant and animal residues, which plays important role in water retention, aggregation and soil structure. It is a measure of soil fertility and could affect the mobility of the metals from soils to plants. Typical amounts of OM in soil vary from <1% in ordinary soil to 90% in bog peat soil and 1% to 20% in mineral soils. OM values obtained in soil were within this range. The relevance of OM to this study is its influence on mobility and flux of trace metals. The normal range of OM obtained signifies that the metals are known to form complexes with organic matter which influences their availability[8].

Control and treated *bottle gourd* plant samples were analyzed for Ni and Pb uptake before and after harvesting on 30th day. Control plant sample was not spiked with Ni and Pb where as treated plant sample was spiked with 500 (mg Ni and Pb kg $^{-1}$). Any symptoms of metal toxicity (e.g., stunting, necrosis, yellowing, pigmentation, discoloration) exhibited by plants were visually noted during the experimental period. But there were no symptoms of metal toxicity on the plant.

The average amount of Ni and Pb accumulated from soil in treated plant on 30th day is 137.0 (mg Ni kg^{-1}) and 144.0 (mg Pb kg^{-1}) which is shown in Graph-1. From the results, it is found that control plant of *(Lagenaria siceraria)* did not show any concentration of nickel and lead uptake where as uptake levels of Ni and Pb in treated plant of *(Lagenaria siceraria)* samples were significantly higher compared to standards[9].

Heavy metals are one of a range of important types of contaminants that can be found on the surface and in the tissue of fresh vegetables. The reason for the uptake of nickel and lead from contaminated soil is that nutrients are easily taken up by food crops. Different vegetable species accumulate different metals depending on environmental conditions, metal species and plant available forms of heavy metals[10] or most of the laboratory research on bio-accumulation of heavy metals indicates that no single mechanism is responsible for metal uptake. In general, two mechanisms are known to occur, viz. 'adsorption', which refers to binding of materials on to the surface and 'absorption', which implies penetration of metals into the inner matrix. Of these or both the mechanisms might take place in the transportation of metals into the plant body.



Graph 1: Concentration of Ni and Pb uptake by *Bottle gourd*

Another reason for contamination of vegetable crops may be due to gradual decline in availability of fresh water to be used for irrigation in India. As a consequence, the use of sewage and other industrial effluents for irrigating and agricultural lands is on the rise particularly in peri-urban areas of developing countries .on the other hand, there is increasing concern regarding the exceedance of statutory and advisory food standards for trace metals through out the world[11]**.**

Probably, food is the most important route for accumulating most chemical elements (essential and toxic). Prolonged human consumption of unsafe concentrations of heavy metals in foodstuffs may lead to the disruption of numerous biological and biochemical processes in the human body and act as carcinogens and others are associated with developmental abnormalities in children and even high levels of nickel and lead in the diet may be associated with an increased risk of thyroid problems, cancer, heart diseases in adults, damage to the nervous system, mental retardation, and even death[12].

Conclusions

Study reveals that vegetable crop *Lagenaria siceraria (bottle gourd)* have the ability to uptake the heavy metals through their roots and transport them to the edible portion of the plant. The heavy metals may accumulate in the edible parts of the crops that are consumed by people or fed to the animals. Their increased concentration in human food chain over a long period can provoke detectable damage to health (carcinogenic and mutagenic effects). This depends not only on the type of heavy metals but also the prevailing soil and other growing conditions. Soil, plant and water quality monitoring, together with prevention of metals entering the plant is a prerequisite in order to prevent potential health hazard of irrigation with sewage fed water/ on contaminated sites. There is no regular testing of heavy metals in vegetables by the designated authorities in India.

REFERENCES

1. Chadha, K.I. and Ramphal. “In advances in horticulture Vegetable crops.” Vol.V, Bulleworths and Co, London, (1993).
2. Geldmacher, V.M. “Meaning of the heavy metals in the toxicology”. *Analytical Chemistry,* **3**(17): 427-432 (1984).
3. Baker, R.S; Schaller and Diez. “Crop response and arsenic uptake following soil incorporation of MSMA”. *Weed Science,* **24**: 322-326 (1976).
4. Fiona Marshell, Sharma R.K and Agarwal. “Heavy metal contamination of vegetable in Delhi”. *Ecology Environment and Conservation*, **3**(5): 117-120 (2003).
5. Kabata Pendias, Flannery L; and Shinde. “Trace elements in soil and plants”. CRC Press, Boca Raton, FL (1989).
6. APHA. “Standard method for the examination of water and wastewater”. American public health association, Washington, DC. (1995).
7. Department of Water Affairs and Forestry-DWAF. “Water Quality Guidelines - Domestic use”. Vol.I, DWAF, Pretoria (1996).
8. Sauve S; McBride MB and Hendershot W. “Soil solution speciation of lead (II): Effects of organic matter and pH”. *Soil Science. Journal,* **62**: 618-621 (1998).
9. Bowen HJM. “*The environmental chemistry of elements*”. Academic press, London, (1979).
10. Lokeshwari H. “Impact of heavy metal contamination of Bellander Lake on soil and cultivated vegetation”. *Asian Jour of Environmental Science*, **6**(12): 167-170 (2006).
11. Singh A.K and Rattan. “Long term impact of irrigation with sewage effluents on heavy metal content in soils, crops and ground water, a case study”. *Agriculture Ecosystem and Environment,* **109**: 310-322 (2005).
12. Andre Luiz and Oliveeria da Silva. “Dietary intake and health effects of selected toxic elements”. *Braz.J. Plant Physiology,* **17**(1): 4-9 (2005).