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Heavy Metal (Zinc) in Cultivated Vegetable Plants Irrigated by Industrial Effluent: Polarographically in Jaipur (India)

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Abstract

Heavy metals (HM) represent a group of metallic elements and metalloids characterized by a relatively density higher than 5 g/cm^3, an atomic number greater than 20. It is a matter of utmost concern that present time agriculture is being threatened constantly by the decline in already depleted resources particularly in soil and water because of increasing population, rapid pace of urbanization and environmental pollution due to industrial mismanagement.

The accumulation of heavy toxic metals above the permissible limit in the industrial waste water can modify the microbial characteristic, and plant growth. Heavy metals are the natural constituent of the earth crust. Several of the heavy metals are essential to the human being. The sources of heavy metal introduction into the environment are mining, piping, combustion of by products and human activities. Heavy metals present in trace amounts are quite beneficial to the human life.

Presence of heavy toxic elements in the soil irrigated with waste water leads to negative influence on the quality of vegetables and fruits with respect to their taste and smell. Thus, knowledge and understanding of chemical composition of soil and water of any region is very essential. The toxic metal concentration can reduce soil fertility and their increased input to food chain leads to the accumulation in food stuff and hence can threaten human health.

Polarographic methods have been used for determination of zinc in selected plant species cultivated irrigating with industrial wastewater in Jaipur. The half wave potential E, was characteristic for zinc identification and diffusion current was proportional to concentration of metals in foodstuffs. The study revealed the presence of heavy metals in most vegetable foodstuffs exceeding permissible limits of UK, WHO and Indian Standards. The method used is reproducible, rapid and can be used in food technology for quality control and human health.

Keywords: Polarographic method, half wave potential, zinc, plant species

Introduction

Today major, concerned towards the environmental pollution with toxic heavy metals. Food chain contamination by them has become a burning issue in recent years because of their potential accumulation in ecosystems through contaminated water, soil and air. Therefore, a better understanding of heavy metal sources and their accumulation in the soil and the effect of their presence in water and soil on plant systems seems to be a particularly important issue of present-day research on risk assessments. The main sources of heavy metals to plants are their growth media (soil, air, nutrients solution) from which these are taken up by the roots or foliage (Sharma *et al.* 2004. This study was therefore, designed to investigate the concentration of the heavy metals in cultivated crops around Jaipur using which is an important electro-analytical tool capable of effective, selective multielement determining at trace to ultra-trace concentrations in vegetables and foodstuffs [7, 13].

Materials and Methods

Jaipur (longitude: 95°24E: latitude: 27° 18 N), a city located at the Centre of Rajasthan state, is undergoing rapid urbanization and industrialization. The wastewaters generated in diverse industries (10) are used for irrigating vegetables and cereals by farmers.

The vegetable samples collected from 4 sites were washed with double distilled water, dried in hot air oven and finally ground to fine powder. One-gram dried powder of each sample was digested in 100 ml Pyrex glass beaker adding 10 ml nitric acid, initially for cold digestion for 24 hours and then heated at 50°C for 4 hours. The solution was finally boiled with 1:5 mixture of HCI: HNO3 to digest all organic matter, cooled, filtered and finally made up to 25 ml in a measuring flask with doubly distilled water. To 1ml of the final solution, 0.1ml of 2.5 M KCl (electrolyte) was added and the mixture was made up to 10 ml with double distilled water [10]. Polarograms were recorded at 25±0.1°C with a manual Polarograph. A saturated calomel electrode used as the reference electrode was connected to the polarographic H-cell by a potassium chloride-agar bridge. Oxygen was expelled by passing a stream of nitrogen through the solution before re-cording the polarograms.

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The mercury used in the DME was obtained from Merck (Darmstadt, Germany). All other reagents used were of analytical grade (Merck). In all re-search, double distilled water was used and contaminated mercury was cleaned by passing it successively through dilute HNO, and water column in the form of fine droplets. The collected mercury was dried between filter paper sheets. A stock matrix standard solution (0.25 M) of zinc was prepared by dissolving $ZnCl_2$, in double distilled water.

Polarograms of different concentration of metal were drawn and diffusion current was measured. Calibration graph for each of the metal was prepared by plotting diffusion current against the concentration of the metal ion. The polarograms of unknown concentration were recorded under identical condition and the concentration of the metal in the solution was determined.

Results and Discussion

The biomagnification of heavy metal was observed in various plant species cultivated at 4 study sites. As per Indian Standards [4] permissible limit of Zinc is 50 mg/kg and other standards [8, 9, 11, 12, 13, 14].

Table 1: Polarographic characteristic of metal ions in wet ashing and tissue concentrations of heavy metals in plant species cultivated at site 1 (Baisgodam Area) during winter

Sample	E1/2 from log Plot Volts Vs SCE	Metal ion	Concentration of metal ion mg/Kg
Sorghum	-0.98	Zinc	1.13
Rose Leaves	-0.98	Zinc	4.97
Pointed Gourd	-0.98	Zinc	0.35
Coriander	-0.98	Zinc	92.0

Table 2: Polarographic characteristic of metal ions in wet ashing and tissue concentrations of heavy metals in plant species cultivated at site 2 (Sanganer area)

Sample	E1/2 from log Plot Volts Vs SCE	Metal ion	Concentration of metal ion mg/Kg
Lady finger	-0.98	Zinc	187.00
Spinach	-0.98	Zinc	65.00
Pointed Gourd	-0.98	Zinc	35.00
Bottle gourd	-0.98	Zinc	145.00

Table 3: Polarographic characteristic of metal ions in wet ashing and tissue concentrations of heavy metals in plant species cultivated at site 3 (Amanishah nalla)

Sample	E1/2 from log Plot Volts Vs SCE	Metal ion	Concentration of metal ion mg/Kg
Cauliflower	-0.98	Zinc	71.00
Spinach	-0.98	Zinc	15.00
radish	-0.98	Zinc	0.39
Bottle gourd	-0.98	Zinc	50.00

Table 4: Polarographic characteristic of metal ions in wet ashing and tissue concentrations of heavy metals in plant species cultivated at site 4 (Malviya Nagar Area)

Sample	E1/2 from log Plot Volts Vs SCE	Metal ion	Concentration of metal ion mg/Kg
Ladyfinger	-0.98	Zinc	10.86
Spinach	-0.98	Zinc	1.44
Bottle gourd	-0.98	Zinc	86.88

The Concentration of Zn in plants sample of site 1 (Baisgodam Area) range between 0.35-92.0mg/kg. The maximum concentration was found in Coriander and the minimum concentration was found in Pointed Gourd.

The Concentration of Zn in plants sample of site 2 (Sanganer area) range between 35.00-187.00 mg/kg. The maximum concentration was found in Lady Finger and the minimum concentration was found in Pointed Gourd.

The Concentration of Zn in plants sample of site 3 (Amanishah nalla) range between 0.39-71.0mg/kg. The maximum concentration was found in Cauliflower and the minimum concentration was found in Radish

The Concentration of Zn in plants sample of site 4 (Malviya Nagar Area) range between 1.44-86.88 mg/kg. The maximum concentration was found in Bottle Gourd and the minimum concentration was found in spinach.

It is evident that zinc concentration is higher in some cultivated food stuff place the consumers at health risk warranting an immediate step to be taken by relevant national and state agencies.

Conclusion

Polarographic methods was used for determination of zinc in selected plant species cultivated irrigating with industrial wastewater in different sites of Jaipur. The identification/estimation of heavy metal zinc using polarography by using polarograms. This gives the half wave potential E, was characteristic for zinc identification and diffusion current was proportional to concentration of metals in foodstuffs. Heavy metals were Analysed in vegetable Samples irrigated with industrial waste water is reproducible with this technique.

Some of the samples were found above Indian, EU and WHO safe permission limit for Zinc.

This indicates that consumers are purchasing vegetables with high level of heavy metal. It is essential for the farmers to educate and encourage to reduce heavy metal accumulation in vegetables by instituting effective countermeasures. It is suggested that regular monitoring of vicinity should be encourage. This is just to avoid possible consumption of contaminated vegetable foodstuffs.

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