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Determination of Heavy Metal Concentration in Cultivated Vegetables - A Case Study of Mysore District

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Abstract: *Our surrounding is filled up with a large number of toxicants in different forms and different composition. These toxicants mat contaminate our water, land and atmosphere where we live. Heavy metal pollution in the environment is a significant issue and problem and has its negative impact on the whole living system including in the agriculture fields. But the heavy metals are also the natural constituents of the environment, but indiscriminate use for human purposes has altered their geochemical cycles and biochemical balance. The more and more quantity of heavy metals may results in toxification in natural resources like the soil and aquatic environments. In this context, the present paper reviews about the quantity of heavy metals accumulated in vegetables and amount of heavymetals present in soil of agricultural fields of selected taluks of Mysuru district.*
Keywords: *Mysuru, Toxicity, Heavy metals, Geochemical cycle, Agriculture.*

I. Introduction

Most of the heavy metals are exist naturally at low concentrations in soils, rocks, water, and biota, sufficient to provide living systems with essential nutrients but at levels too low to cause toxicity. Since the industrial revolution, heavy metals have become a seriously pervasive pollutant in environment, through industrial effluents and landfill leaching, mining activities, fertilizer and pesticide use in agriculture, the burning of waste and fossil fuels, and municipal waste treatment (Diels *et al*., 2006). Once these heavy metals have been released into the environment, they cannot be degraded and will accumulate in the environment persistently, including the food chain. Exposure to heavy metals through uptake of drinking water or foods can lead to their accumulation in plants, animals and humans (Mulligan *et al*., 2001). But now the conventional heavy metals contaminated wastewater or soil treatments, such as chemical precipitation or ion exchange and adsorption are not effective or uneconomical (Kapoor and Viraraghavan, 1995; Matheickal *et al*., 1997; Cheung and Gu, 2007).

Microbial processes that bind metals and form minerals are widespread and represent a fundamental part of key biogeochemical cycles (Cheung *et al*., 2006; DeJong *et al*., 2006; Stanislav and Tomas, 2006; Cheung and Gu, 2007; Han and Gu, 2010; Veronica *et al*., 2012). Carbonate precipitation is an important aspect of biomineralization, and has been investigated extensively due to its wide range of technological implications.

Some of the heavy metals act as micronutrients for the growth of animals and human beings when present in trace quantities, whereas others such as Cd, As, and Cr act as carcinogens (Feig *et al*., 1994; Trichopoulos, 1997). The contamination of vegetables with heavy metals due to soil and atmospheric contamination poses a threat to its quality and safety. Dietary intake of heavy metals also poses risk to animals and human health. Heavy metals such as Cd and Pb have been shown to have carcinogenic effects (Trichopoulos, 1997). High concentrations of heavy metals (Cu, Cd and Pb) in fruits and vegetables were related to high prevalence of upper gastrointestinal cancer (Turkdogan *et al*., 2002).

II. Materials And Methods

Vegetable samples were collected and samples were classified as fruits, green vegetables, leafy vegetables and general (tubers, bulbs, bean and rice), according to CEAGESP. In each group, only the most commonly traded vegetables in 2008 were collected, comprising 223 samples of 83 plant species. Samples were identified and packed into polyethylene bags. In the laboratory, they were washed following the same procedures as for food preparation to remove any surface deposits (Chary *et al*., 2008). Then, the vegetables were rewashed with deionized water and separated into edible and non-edible parts. The edible parts were air-dried at 65ºC, weighed and finely ground in a Willey mill.

Acid digestion and metals determination of samples Tri-acid mixture (15 ml, 70% high purity HNO3, 65% HClO4 and 70% H2SO4; 5:1:1) was added to the beaker containing 1 g dry vegetable sample (Allen et al., 1986). The mixture was then digested at 80 _C till the transparent solution was achieved. After cooling, the digested samples were filtered using What man No. 42 filter paper and the filtrate was diluted to 50 ml with deionised water and were determined by atomic absorption spectro photometry (Varian-SpectrAA 140).

Soil sampling:

- Divide the study area into sampling points so that each sample represents an area of not more than 6 acres.
- Fix sampling spots to represent the study area.
- Scrape away the surface litter, stones etc. and collect samples in to a bucket from each spot up to the required depth by making a 'V' shaped cut by using a spade. Take a slice of soil from both the sides. Collect the same quantity from each of sampling spots. Place the sample on a plastic sheet and mix by discarding stones, roots etc. and take out the required quantity of soil in to polythene bag by adapting quartering technique.

Table 1: Soil Sampling Stations

Serial No	Station code	Name of the Taluk	Village
1	P1	KR NAGAR	Mirle
2	P2	HUNASUR	Hirikyathanahalli
3	P3	PERIYAPATNA	Chittena halli
4	P4	NANANAGUD	Doora
5	P5	HD KOTE	H M Halli

III. Results And Discussion

The results of the present studies were summarized in Table 2. The concentrations of the heavy metals was estimated thorough ICP-MS for the Cd, Ni, Pb, Cu and Cr. The concentrations of heavy metals was estimated by crushing the whole plant body including root and compared with the corresponding permissible limits established by National Agency for Sanitary Vigilance (Anvisa) (1965). According to Anvisa, the permissible limits for Cd, Ni, Pb and Cr are 1.0, 5.0, 0.5 and 0.1 mg kg–1, respectively (fresh weight), with no recommendation for Co.

The daily intake of Cd was estimated as 0.008 mg, which represents approximately 10.7 % of the RfD, established to 0.001 mg kg–1 of body weight per day, equivalent to 0.07 mg per day for a 70 kg adult (*WHO*, 1993). The daily intake was lower than the tolerable daily intake (TDI). In the present study the concentration ranged from 0.06 mg/kg to 0.31 mg/kg

Cr is an important element for the insulin activity and DNA transcription. However an intake below 0.02 mg per day could reduce cellular responses to insulin (Kohlmeier, 2003). The daily intake, estimated as 0.016 mg, was lower than the RfD established at 1.5 mg kg–1 per day (equivalent to 105 mg per day) (US EPA, 2010). This value was also lower than that recommended by the US National Council (NRC, 1989) for Cr3+: from 0.05 to 0.2 mg.). In the present study the concentration of Cr ranged from 0.06mg/kg to 1.2mg/kg

Ni content in the adult human body should remain below 0.1 mg per day, and excess may cause damages to DNA and cell structures (Kohlmeier, 2003). The daily intake of Ni was estimated as 0.046 mg, which represents approximately 3.3 % of RfD established in 0.02 mg kg–1 per day, equivalent to 1.4 mg per day for a 70 kg adult (WHO, 1993). The present research measures about 0.08 mg/kg to 0.81 mg/kg.

Copper can be found in many kinds of food, in drinking water and in air. Because of that we absorb eminent quantities of copper each day by eating, drinking and breathing. The absorption of copper is necessary, because copper is a trace element that is essential for human health. Although humans can handle proportionally large concentrations of copper, too much copper can still cause eminent health problems. In the present study the copper was estimated about 0.17mg/kg to 1.2 mg/kg.

The Leafy vegetables tend to accumulate high amounts of Cd, Ni, and Pb due not only to their large leaf area and high transpiration rate, but also to the fast growth rate of these plants as observed by Itanna (2002). However, concentrations of Pb, that exceeded the established permissible limit of 0.5 mg kg–1, were not observed for a specific class of vegetables in this study.

Table 2 – Concentrations of heavy metals in selected vegetables of Mysuru district.

Vegetables	Scientific Name	Cd	Ni	Pb	Cu	Cr
Purple Cabbage	*Brassica oleracea L*	0.06	0.28	1.26	0.68	0.51
Rocket	*Eruca sativa* L.	0.1	0.37	0.81	0.4	0.4
Cauliflower	*Brassica oleracea* var *botrytis*	0.09	0.2	0.47	0.38	0.21
Crisphead Lettuce	*Lactuca sativa* L.	0.18	0.41	0.32	0.42	0.38
Smooth Lettuce	*Lactuca sativa* L.	0.12	0.24	0.52	0.18	0.16
Coriander	*Coriandrum sativum* L.	0.24	0.7	1.1	0.62	0.17
Cabbage	*Brassica oleracea var. acephala D.C.*	0.28	0.68	1.4	1.2	1.2
Endive	*Cichorium endivia* L.	0.12	0.48	0.78	0.28	0.31
Chard	*Beta vulgaris* L. var. *cicla*	0.09	0.18	0.8	0.17	0.16
Watercress	*Nasturtium officinale* sp.	0.1	0.42	0.76	0.62	0.5
Sweet corn	*Zea Mays* L.	0.08	0.08	0.41	0.62	0.27
Spinach	*Tetragonia expansa*	0.15	0.41	1.34	0.78	0.35
Broccoli	*Brassica oleracea L*	0.09	0.31	1.2	0.48	0.72

Celery	*Apium graveolens* L.	0.09	0.29	1.1	0.41	0.28
Parsley	*Petroselinum crispum* (Mill.) Nym.	0.31	0.81	1.3	0.71	0.3
White Cabbage	*Brassica oleracea* L. var. *capitata*	0.08	0.19	0.87	0.41	0.2
Iceberg Lettuce	*Lactuca sativa* L.	0.08	0.19	0.34	0.18	0.38

Although the HQ-based risk assessment method does not provide a quantitative estimate for the probability of an exposed population experiencing a reverse health effect, it indeed provides an indication of the risk level due to exposure to pollutants (Chary *et al*., 2008). Many researchers consider the risk estimation method reliable (Chary *et al*., 2008; Khan *et al*., 2008; Wang *et al*., 2005) and it has been proven to be valid and useful. However, this HQ method considers only exposure to HMs via consumption of vegetables, without taking into account other vias like dermal contact, soil ingestion, and other factors such as the presence of agrochemicals and herbicide molecules.

Table 3: Values of Hazard Quotients (HQ) and Hazard Index (HI).

Population	Cd	Ni	Pb	Co	Cr	HI
Adults	0.107	0.033	0.417	0.013	0.00015	0.57
Children	0.130	0.039	0.499	0.016	0.00018	0.68

When the hazard index exceeds 1.0, there is concern for potential health effects (Huang et al., 2008). Even though there was no apparent risk when each metal was analyzed individually, the potential risk could be multiplied when considering all HMs. HI for adults and children were 0.57 and 0.68, respectively (Table 6). Although HI was higher for children, neither population suffered from ingestion of vegetables contaminated with HMs.

IV. Conclusion

Heavy metal contamination of vegetables cannot be underestimated as these foodstuffs are important components of human diet. Vegetables are rich sources of vitamins, minerals, and fibers, and also have beneficial antioxidative effects. However, intake of heavy metal-contaminated vegetables may pose a risk to the human health. Heavy metal contamination of the food items is one of the most important aspects of food quality assurance. The uptake of heavy metals in vegetables are influenced by some factors such as climate, atmospheric depositions, the concentrations of heavy metals in soil, the nature of soil on which the vegetables are grown and the degree of maturity of the plants at the time of harvest The obtained results declared that concentrations of major studied metals were exceeding than the recommended maximum acceptable levels proposed by the Joint FAO/WHO Expert Committee on Food Additives.

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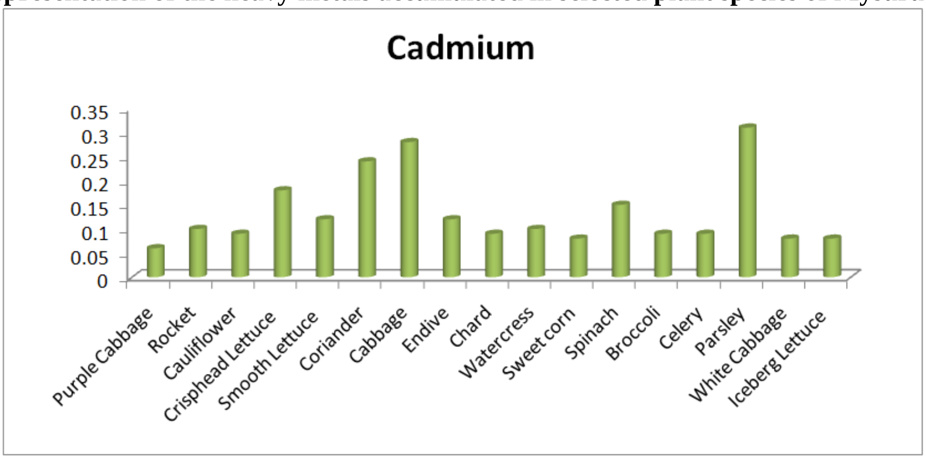
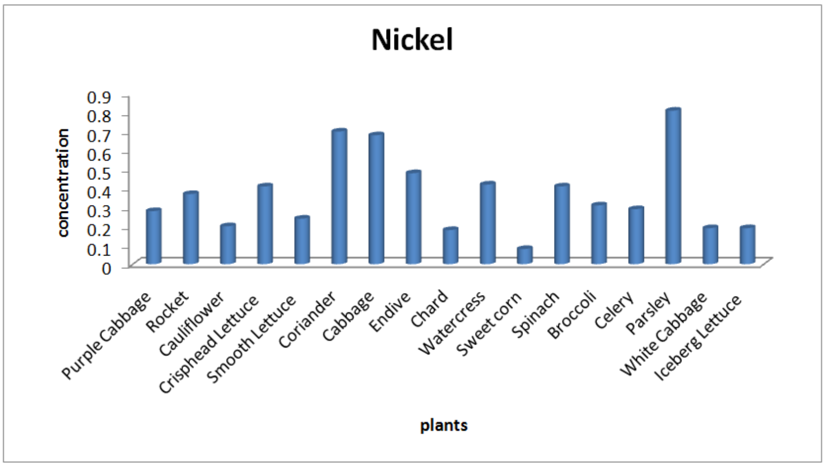
Graphical representation of the heavy metals accumulated in selected plant species of Mysuru district

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Rocket
Cauliflower
Crisphead Lettuce
Smooth Lettuce
Coriander
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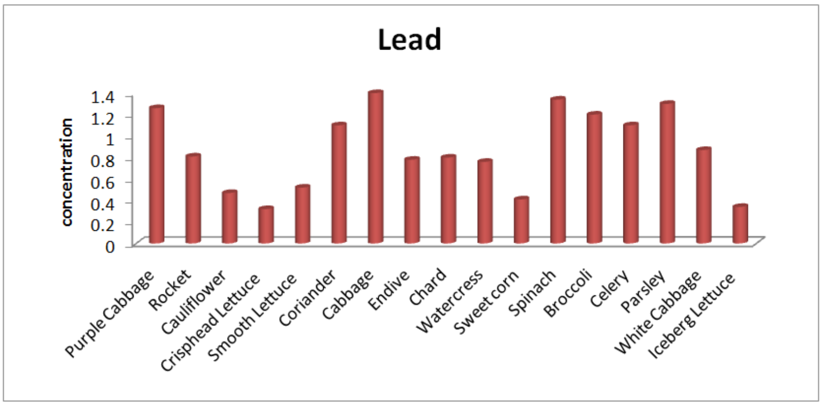
Endive
Chard
Watercress
Sweet corn
Spinach
Broccoli
Celery
Parsley
White Cabbage
Iceberg Lettuce
plants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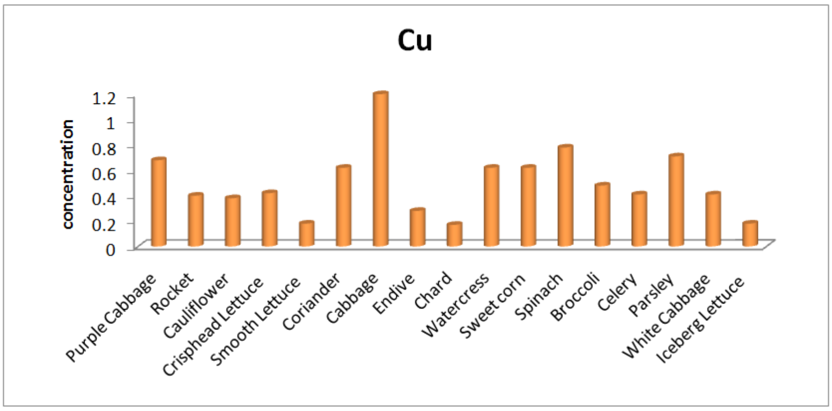
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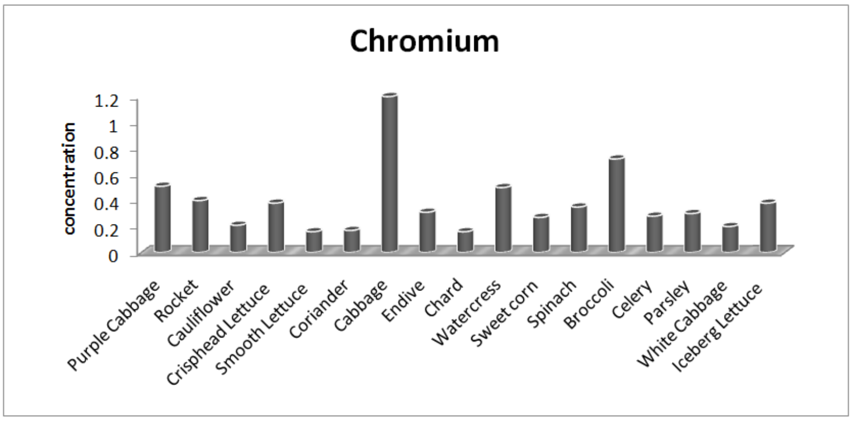
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