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Original Research Paper

Environmental Science

ANALYSIS OF TOXIC METAL CONTENTS FROM VEGETABLES AND LEAFY VEGETABLES

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ABSTRACT The present work is carried out to assess the risk that is caused to humans due to intake of vegetables contaminated with heavy metals which are toxic at certain level owing to neurotoxic, carcinogenic effects. Heavy metals (Pb, Cd, Co, Ni and Zn) in few leafy vegetables like amaranthus sps., spinach and sorrel leaves and vegetables like potato, tomato and brinjal from local markets was analyzed by using atomic absorption spectrophotometer. It was found that spinach has the highest metal content of all the leafy vegetables and potato has highest content within all the selected vegetable species.

KEYWORDS :leafy Vegetables, Vegetables, Heavy Metals, Atomic Absorption Spectrophometer (AAS)

I. INTRODUCTION

In recent decades industrialization is leading to the build-up of environmental pollutants by entering into food chain in number of ways becoming an imminent danger to the health of both human and animal population. Anthropogenic activities have altered the environment significantly throughout the world like mining, industry and agriculture. The modern life style has deeply changed the way of food preparation and consumption. The natural uptake of vitamins, minerals, sugars, pectin, fibres, etc. in humans is achieved by fruits and vegetables consumption. The increasing demand for food safety stirred research regarding the risks associated with consumption of foodstuffs contaminated by pesticides, heavy metals and toxins. Food safety issues and potential health risks are one of the major environmental concerns.

Air, water, soil and food are all unavoidable components of the human environment. Each of those elements influences the quality of human life. Food chain contamination by heavy metals has become a burning issue in recent years because of their potential accumulation in bio-systems through contaminated water, soil and air. On the other end insufficient water and land resources making farmers to grow vegetables in sub-urban utilizing drainage or sewage water. Consumers could be at risk of harmful health effects from market vegetables grown in heavy metal contaminated soils or environment.

Although metals are considered toxic some trace metals are essential for plant nutrition. However plants growing in a pollute environment can accumulate trace elements at high concentra tions, causing a serious risk to human health. The problem of environmental pollution due to toxic metals has begun to cause concern now in most major metropolitan cities. Anthropogenic activities, such as mining, industrial effluents and sewage sludge application, are the main sources of heavy metal contamination in the environment.

What so ever, urban food security in India is a matter of growing concern. The rapid urbanization, industries, municipal waste and agro-waste around the periphery of the cities have largely deteriorated the quality of land, water and other natural resources. The presence of heavy metals in human body always draws scientific concern as these are considered responsible for affecting health, especially in these days where the release of toxic wastes in the environment has been increased. The increasing trends in food contamination in urban areas are largely attributed to the polluted environment in urban agriculture, contaminated food transport and supply chains, poor market sanitary conditions, and the use of contaminated or waste water for irrigation.

Present scenario:

India has emerged as the second largest producer of vegetables after China, contributing to about 14 percent to the world vegetable production. India grows the largest number of vegetables from temperate to humid tropics and from sea-level to snowline.

Dietary requirement of vegetables:

There have been innumerable research studies all over the world that strongly suggest having fresh, green vegetables on a regular basis is far better than going for supplementary tablets to get the wholesome nutrition that we require. Vegetables are an excellent source of vitamins particularly niacin, riboflavin, thiamin and vitamins A and C. They also supply minerals such as calcium and iron besides proteins and carbohydrates. Vegetables combat under nourishment and are known to be cheapest source of natural protective tools.

Leafy greens run the whole gamut of flavors, from sweet to bitter, from peppery to earthy. Going for greens helps us to stay fit, healthy and happy. Leafy vegetables are ideal for weight management as they are typically low in calories. Green vegetables are also a major source of iron and calcium for any diet.

Status of Indian vegetable market:

India is one among the vegetable and fruit basket in the world. The total vegetable production in India before independence was 15 million MT. During the year 2013 the production of vegetables in the world was estimated to be 1135.69 million Tons and in India it was estimated to be 121.02 million Tons (FAO 2015).

India is the largest producer of ginger and okra amongst vegetables and ranks second in production of potatoes, onions, tomatoes, brinjal (egg plant), cauliflowers, beans, cabbages, cucumber, garkin, frozen peas, garlic etc. The major importing Countries from India are United Arab Emirates, Pakistan, Nepal, United Kingdom and Qatar. Many studies have earlier proved that in developing Country like India agriculture is a key sector in economy which has proven to have a potential impact on other sectors defining the financial system.

Status of vegetables in Andhra Pradesh and Visakhapatnam:

Andhra Pradesh produces about 23.32 m.MT of horticulture produced from an area of 1.9 m ha, accounting for 9.70% of total horticulture production in the country. Major share of production is around 51% for vegetables and 40% for fruits. It was found that Andhra Pradesh is the fourth leading producer of vegetables after West Bengal, Uttar Pradesh and Bihar contributing to about 8.1% of

the total vegetable production in the country. The main vegetables like brinjal, okra, onion, peas, potato and tomato are cultivated here with a trade of 10.69 Lakh MT in organized markets.

Trends in agricultural practices:
In olden days farmers cultivated crops basing on natural conditions which resulted in lower yield. With the advent of modern agricultural practices farmers cultivated crops using advanced techniques that resulted in high yield with elevated levels of problems causing degradation of land and decrease in quality of food. When grown on contaminated soils toxic metals are accumulated in vegetables resulting in reduction of yields due to the inhibition of metabolic processes.

Heavy metals and effects:
Heavy metals are those elements with densities greater than 5.0 g cm−3 and also indicate their association with pollution and toxicity. In general, these are not biodegradable, have long biological half-lives and have the potential for accumulation in different body organs leading to unwanted side-effects. Fifty three of the ninety naturally occurring elements are heavy metals. Due to their toxicity these metals have received special attention globally owing to neurotoxin, carcinogenic and several other impacts arising from their pollutants mainly of anthropogenic origin.

Toxicological significance of heavy metals has been recognized several decades ago in developed countries. However, developing countries lag behind in this area of research and scanty effort has come forth. In recent years there are a number of reports on heavy metal contamination in fruits and vegetables by different authors. The occurrences of heavy metals-enriched ecosystem components, firstly, arise from rapid industrial growth, advances in agricultural chemicalization, or the urban activities of human beings. These agents have led to metal distribution in the environment and, consequently, impaired health of the population by the ingestion of victuals contaminated by harmful elements. The majority of the known metals and metalloids are very toxic to living organisms although some are considered essential for nutritional requirement.

II. MATERIALS AND METHODS:

Status of vegetables in Andhra Pradesh and Visakhapatnam:
Andhra Pradesh produces about 23.32 m.MT of horticulture produced from an area of 1.9 m.ha, accounting for 9.70% of total horticulture production in the country. Major share of production is around 51% for vegetables and 40% for fruits. It was found that Andhra Pradesh is the fourth leading producer of vegetables after West Bengal, Uttar Pradesh and Bihar contributing to about 8.1% of the total vegetable production in the country. The main vegetables like brinjal, okra, onion, peas, potato and tomato are cultivated here with a trading of 10.69 lakh MT in organized markets.

Sampling Site:
During the study one major vegetable market in the study area have been identified for sample collection which is as follows:

Table no 3.1: Sampling site in study area

Site	Latitude	Longitude
Gajuwaka	17°44'28.82"N	83°20'7.84"E

Gajuwaka market:

Gajuwaka is an industrial area located almost 15kms south of Visakhapatnam city. Majority of the people in gajuwaka purchase vegetables and leafy vegetables from this market only.

Sample Collection methodology:
Fresh vegetables and green leafy vegetable samples were collected from the Gajuwaka Market during the years 2014-2016. Samples were collected randomly from different vendors in triplicates into a polythene bag. The following are the species selected for the study.

Table no 3.2: Selected plant species

S.No	Family	Scientific Name	Common Name
Vegetables			
1.	Solonaceae	*Solanum tuberosum.* L	Potato
2.		*Solanum lycopersicum.* L	Tomato
3.		*Solanum melongena.* L	Brinjal
Leafy Vegetables			
4.	Amaranthaceae	*Amaranthus viridis.* L	Amaranthus
5.		*Spinacia oleracea.* L	Spinach
6.	Malvaceae	*Hibiscus cannabinus.* L	Sorrel Leaves

Selection of heavy metal:
Five heavy metals namely Lead (Pb), Cadmium (Cd), Cobalt (Co), Zinc (Zn) and Nickel (Ni) have been selected for the analysis in vegetables and leafy vegetables from gajuwaka market of Visakhapatnam.

Metal extraction procedure:
I) Preparation of the Homogenized sample:
The vegetable and leafy vegetable samples were washed thoroughly with tap water as well as with distilled water to remove any soil and dust particles. These samples were made into small pieces with a clean and sharp knife and sun dried for few days. Later samples were grinded into fine powder with the help of mortar and pestle to obtain homogenized samples and store at room temperature in airtight sealed polyethylene bags until required for further analysis.

ii) Standard solution:
Standard solutions of heavy metals, namely lead (Pb), cadmium (Cd), cobalt (Co), nickel (Ni) and zinc (Zn) were provided by Merck. Different standard solutions were prepared by diluting with the help of distilled water using 1000 ppm analytical grade salt solution.

iii) Homogenized Sample Solution Preparation:
The homogenized samples were used for metal extraction after wet digestion technique as described in AOAC 1990. About 0.5gm of the homogenized samples was weighed and treated with 5ml conc. HNO_3 and 1ml H_2O_2 on hot plate until complete digestion (i.e., clear solution is obtained). The digest thus obtained was allowed to cool and later filtered through Whatman filter paper 42. Thus the homogenized sample solution is prepared by making the final volume of filtered homogenized sample upto 50-ml in a volumetric flask with double distilled water which was used for analyzing in an Atomic Absorption Spectrophotometer by using Aluka standards for the metals lead (Pb), cadmium (Cd), cobalt (Co), zinc (Zn) and nickel (Ni). analysis by Atomic Absorption Spectrometry (AAS) after

Procedure:
The homogenized sample solution was further analyzed for metal content from the standards prepared for various metals to determine the sample concentration using Atomic Absorption Spectrophotometer (Perkin Elmer 240 model).

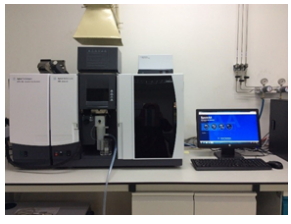

Figure 1: Atomic Absorption Spectrophotometer

I. RESULTS AND DISCUSSIONS

Amaranthus viridis. L:
In *Amaranthus viridis*. *L* the range of heavy metals recorded was as lead (0.03-2.1 ppm), cadmium (0.05-0.18ppm), nickel (0.1-0.78ppm),

cobalt (0.05-0.6ppm) and zinc is (0.08-0.98ppm). The mean metal concentration levels in species collected from Gajuwaka in *Amaranthus viridis L*. was lead (2.75ppm), cadmium (0.10ppm), nickel (0.61ppm), cobalt (0.41ppm) and zinc (0.61ppm) respectively. Of all the metals lead was found to be the highest and cadmium is the lowest. During the study sequence of heavy metals analyzed followed a sequence of Pb>Ni>Zn>Co>Cd as shown in Figure 1.

Hibiscus cannabinus. L:

In *Hibiscus cannabinus. L* the range of values for heavy metals was recorded as lead (0.4-0.9 ppm), cadmium (0.01-0.09 ppm), nickel (0.45-1.1 ppm), cobalt (0.02-1.16 ppm) and zinc (1.1-1.8 ppm) respectively. The mean metal concentration was lead (0.77 ppm), cadmium (0.03 ppm), nickel (0.73 ppm), cobalt (0.83 ppm) and zinc (1.75 ppm). Of all these heavy metals zinc has the highest concentration and cadmium has the lowest metal concentration. The sequence was in the order of Zn>Co>Pb>Ni>Cd as shown in Figure 1.

Spinacia oleracea. L:

In *Spinacia oleracea. L* the range of heavy metals was recorded as lead (1.3-1.93 ppm), cadmium (1.21-1.95ppm), nickel (0.06-0.16ppm), cobalt (0.75-1.13ppm) and zinc (1.16-1.43ppm) respectively. The mean value of heavy metals in lead, cadmium, nickel, cobalt and zinc are 1.69ppm, 1.28ppm, 0.08ppm, 0.83ppm and 1.33ppm respectively. Of them lead was found to have highest concentration and nickel is having lowest concentration. The order of heavy metal accumulation in this plant species was Pb>Zn>Cd>Co>Ni as shown in Figure 1.

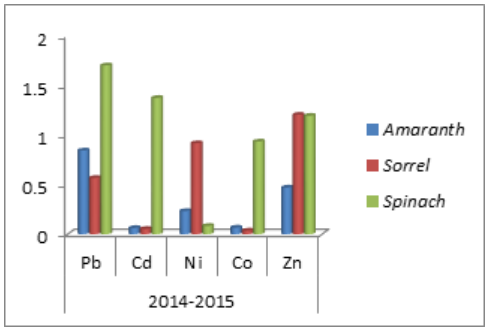

Fig.1: Comparison of Metal Content in Leafy Vegetables

Solanum lycopersicum. L:

In *Solanum lycopersicum*. L the range of heavy metals was recorded as lead (0.09-2.1 ppm), cadmium (0.12-0.66 ppm), nickel (0.04-1.23 ppm), cobalt (0.07-0.46 ppm) and zinc is (0.15-0.27 ppm). The mean metal levels in *Solanum lycopersicum*. L. is lead (0.92 ppm), Cadmium (0.48 ppm), nickel (0.85 ppm), cobalt (0.51ppm) and zinc (1.38 ppm) respectively. Of all the metals zinc was found to be the highest and cadmium is the lowest. During the study the sequence of heavy metals analyzed followed a sequence of Zn>Pb>Ni>Co>Cd as shown in Figure 2.

Solanum melongena. L:

In *Solanum melongena.* L the range of heavy metal concentrations was found to be 0.13- 0.26 ppm for lead, 0.07- 0.63 ppm for cadmium, 0.03- 0.29 ppm for nickel, 0.06- 0.1 ppm for cobalt and 0.2-0.3 ppm for zinc respectively. The mean values were observed to be lead (0.17ppm), cadmium (0.35 ppm), nickel (0.22 ppm), cobalt (0.10 ppm) and for zinc (0.28 ppm). Of them maximum concentration was found in cadmium and minimum concentration was found in cobalt. The sequence of heavy metal concentrations are in the order of Cd>Zn>Ni>Pb>Co as shown in Figure 2.

Solanum tuberosum. L:

In *Solanum tuberosum*. L the range of different heavy metal concentrations was lead (1.26-1.28 ppm), cadmium (0.18-0.82 ppm), nickel (0.19- 0.98 ppm), cobalt (0.08-0.2 ppm) and for zinc (0.32- 0.85 ppm). The mean values for these heavy metals are for lead (1.30 ppm), cadmium (0.79 ppm), nickel (0.38 ppm), cobalt (0.15 ppm) and zinc (0.65 ppm). Among these metals highest concentration was observed in lead and lowest was found in cobalt. The sequence of heavy metal concentration was in the order of Pb>Cd>Zn>Ni>Co as shown in Figure2.

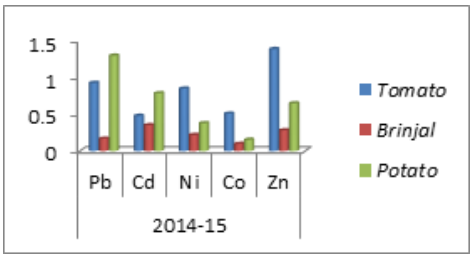

Fig.2: Comparison of Metal Content in Vegetables

CONCLUSIONS

We can conclude that Spinach is having maximum Lead (Pb), Cadmium (Cd) and Cobalt (Co) content than Sorrel Leaves and Amaranth Leaves and Sorrel Leaves is having maximum Nickel (Ni) and Zinc (Zn) content than Spinach and Amaranth Leaves.

In case of vegetables, Potato is having maximum Lead (Pb) and Cadmium (Cd) content than Tomato and Brinjal and Tomato is having maximum Nickel (Ni), Cobalt (Co) and Zinc (Zn) content than Potato and Brinjal.

When we consider Leafy Vegetables and Vegetables, Leafy Vegetables are having maximum metal content when compared with Vegetables.

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