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Detection of heavy metals in green leafy vegetables from North Mumbai, Maharashtra, India

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Abstract

Green leafy vegetables are the part of daily meal and also important constituent of balanced diet. Heavy metals are naturally occurring element with high atomic weight and density. Various anthropogenic activities produce effluent which builds up runoff water and consequently bleaches into soil adding to heavy metal contents of soil. Green leafy vegetables absorb water through this soil polluted with heavy metals. Former studies highlighted presence of heavy metals in green leafy vegetables. Current study focuses on detection of heavy metal concentration in Spinach from three vegetable markets of Dahisar (D), Mira road (M) and Bhayandar (B). Samples were analysed using atomic absorption spectrometer. Zinc was detected in highest concentration in spinach samples from all locations. Samples from Dahisar showed concentrations of Copper, lead and Zinc, far more than WHO suggested acceptable limit. Chromium was found to be more than WHO limit in spinach sample collected from Dahisar, Mira road and Bhayandar. Remaining metals were found to be in permissible limit. However, persistent consumption of these contaminated leafy vegetable will certainly result in severe health consequences. Therefore, a continuous monitoring and assessment of heavy metal concentration in Spinach plus other green leafy vegetables is required.

Keywords: Detection, heavy metals, green leafy, vegetables.

Introduction

Vegetables are the part of day to day life without which the food is incomplete and also they are the important constituent of balanced diet. As in the Indian subcontinent, staple food is starch based therefore, green leafy vegetables are key components of vitamins, minerals and antioxidants diet. During recent times there is an upsurge in the consumption of leafy vegetables, particularly among the urban communities, which is owes to increased consciousness on their great nutritious and herbal values[1]. These vegetables contains natural polyphenols that have been found to employ their favourable influence by eliminating free radicals, chelating metal catalyst, activating antioxidant enzymes etc. Studies conducted by Epidemiologists shows evidences which propose that optimum ingestion of vegetables is associated to reduced risk of developing most oxidative stress- induced diseases[2,3]. Moreover Leafy vegetables are gaining lot of attention now a days as a part of weight management diet plan because of low calories contents. These green leafy vegetables also have low fat and high in dietary fibre content. They are also rich in potassium and magnesium, folic acid vitamin C. They also contain phytochemicals, for instancebeta-cryptoxanthin, beta-carotene, lutein and zeaxanthin which play important role in plummeting the threat of heart disease and cancer. For people with type 2 diabetes green leafy vegetables are valuable because of their rich magnesium content as well as low glycemic index. They also possess high level of vitamin K. In recent times however, these green leafy vegetables are garnering more focus being a potent source of heavy metals.

Naturally occurring element with high atomic weight are called heavy metals and they have density greater compared to water[4]. Heavy metals occur naturally in the earth's crust. However, it is to be kept in mind that maximum contamination of soil results from anthropogenic activities like smelting operations and mining, industrial, agricultural domestic use of the heavy metals and metal-containing composites[5-8]. All the effluent produced in through various anthropogenic activities ends up building runoff water and consequently bleaches into the soil adding to the heavy metal contents of soil[9-11]. Green leafy vegetable sabsorb water through this contaminated soil along with heavy metals present in it. The capability of green leafy vegetables to absorb heavy metals deposited on plant exteriors raises the contamination ofenvironment[9]. The edible parts of the plants accumulate these absorbed heavy metals therefore[12], persistent exposure to such heavy metal contaminated soil keeps on increasing the amount of heavy metals absorbed by the vegetables. If humans consume such vegetables comprising high levels of heavy metals, it may lead to several clinical and physiological problems[13,14].

Heavy metals such as Mn, Cr, Zn, Cu, Ni, and Fe are essential constituents for several biological actions in the human body, however, several health concerns are raised owing to the elevated levels of heavy metals. Cd, Hg and Pb, in contrast, are

non-essential, lethal components accompanied with number of chronic sicknesses in humans[15]. All the after effects of heavy metal exposure are related to the tendency of these metal to accumulate in the tissues of the body called bioaccumulation[16]. Moreover, as a result of the obstinate nature and aggregate actions of heavy metals, they are capable of mount up through food chains and provoke noxious health consequences in human[17]. Heavy metals cannot be removed from the tissues easily. Consistent exposure to these metals leads to increased accumulation in the tissues called bio-magnification[18].

It is possible that most Green Leafy Vegetables sold in local markets probably are grown at roadside, alongside of the railway lines etc. These areas are most likely to be profoundly adulterated with heavy metal-loaded drain. Rapid industrial development alongside urbanization have set off traffic activities in the vicinity of the tilling region of vegetables. This subsequently have added to significant accumulations of heavy metals in cultivation grounds. Additionally, widespread range of small scale industries also contribute to the heavy metal build-up in the environment. Subsequently, these toxic metals might be dumped on the surface of vegetables during production, transportation and selling[19,20]. These Green Leafy Vegetables may also get contaminated while washing them with heavy metals polluted water before transporting them to the marketplaces. Therefore, it becomes essential to check that whether most consumed green leafy vegetables marketed in local markets in very urbanized areas are polluted with heavy metals or not.

Former studies on heavy metals concentrations of lead, copper, cadmium, arsenic, zinc, chromium etc. in green leafy vegetables such as spinach, fenugreek etc. have been done by various researchers in different parts of India[21-30]. In Nasik, Maharashtra, the concentration of lead, cadmium, arsenic and copper have been recorded from randomly collected samples of spinach and coriander form different sites[31].

In Navi Mumbai, Maharashtra also concentrations of heavy metals in leafy vegetables have been studied[32]. As there are not many references available in northern Mumbai area, the current study deals with Spinach samples, collected from three local vegetable markets of North Mumbai which were assessed to detect of concentration heavy metal in them.

Materials and methods

Collection of samples: Spinach samples were collected from three local vegetable markets of North Mumbai–Dahisar (D), Mira road (M) and Bhayandar (B).

Analysis of samples: Samples were analysed in three replicates using atomic absorption spectrometer [Thermo] Solar M-6 Series. 5 gm of each spinach sample were digested in 5 ml of nitric acid and was used to estimate the heavy metal concentration.

The heavy metals selected for the study were Cadmium, Chromium, Copper, Nickel, Lead and Zinc.

Results and discussion

The concertation of heavy metals recorded in Spinach from different samples taken for the studies are given in Table-1.

Table-1: The concentration of heavy metals found in spinach samples in ppm.

Sample	Cd	Cr	Cu	Ni	Pb	Zn
D	ND	42.17	81.37	15.78	37.22	216.72
M	ND	25.33	34.59	10.42	ND	72.32
B	ND	21.54	35.21	5.44	ND	50.12

Zinc [Zn] was detected in highest concentration in spinach samples collected from all three locations. However sample collected from Dahisar exhibited zinc contents > 200 ppm. The lowest concentration was detected in Bhayandar [50.12 ppm]. Maximum permitted level for Zinc in vegetables by WHO is 100ppm[33]. So it is clear that spinach samples from Dahisar contain much higher amount of Zn than the permissible limit. It has been reported that high concentration of Zn in vegetables may cause vomiting, renal damage, cramps etc.[34].

Copper [Cu] was second highest heavy metal detected in sample from Dahisar (81.37 ppm).Lowest copper concentration was recorded in samples collected from Mira road [34.59 ppm]. The maximum permissible limit for Cu in vegetables by WHO is 73 ppm[33]. Acute effects of copper, include nausea and vomiting whereas in in sensitive human populations, chronic copper toxicity targets liver resulting in liver diseases[35].

Chromium (Cr) contents were detected to be highest in samples from Dahisar [42.17 ppm] and lowest in Bhayandar [21.54 ppm]. WHO recommended maximum permissible limit for chromium intake from vegetables is 0.05ppm[33]. It is quite evident from current studies that quite high amount of heavy metals than permissible limit. The three samples of spinach contained. Consumption of chromium in high dosages is able to inflict stomach distress, itching and flushing, uneven heartbeats in human. Besides chromium can give rise to kidney and liver impairment with ulceration[36-41].

Lead (Pb) was detected only in spinach samples from Dahisar (37.22 ppm). Maximum permissible Pb limit by WHO standards is 0.3 ppm[33]. Pb is non-vitallethal element which causes oncogenic effects and teratogenic anomalies in human, even at very little concentrations[42]. It has been reported that, if Pb absorbed by crops from the soil, it cannot efficiently pass the endodermis of roots[43], however, Leaves can absorb massive amounts of Pb from the atmosphere. It has been reported that Pb

is an acute cumulative body contaminant which move in the body through air, food and water and cannot be eradicated by washing the vegetables[44,45]. Although plants typically display capacity to accumulate large amounts of lead lacking noticeable changes in their appearance or yield; Pb is a toxic element which can be harmful to plants. In several plants, Pb accumulation can surpass quite a few hundred times the threshold of maximum level permitted for human ingestion[46]. There is no biologically acknowledged function Lead has in the human body, and thus entry of it in the body, imparts severe health hazards which might be long-lasting leading to mortality[47]. Hematopoietic, renal, reproductive, and central nervous system are among the human body and systems parts that are vulnerable toward the endangerments subsequent to the acquaintance to high level of Pb[47].

Nickel [Ni] was found to be highest again in spinach samples from Dahisar [15.78 ppm] and the lowest in Bhayandar [5.44 ppm]. WHO permissible limit for nickel consumption is 67 ppm[33]. Though in present study spinach sample showed nickel concentration below permissible limit prolonged exposure to nickel may cause hazardous health effects[48]. Nickel most commonly causes contact allergic reactions. The plant tend to absorb the water from the soil and if the water is contaminated with the heavy metals then it is quite obvious that the plant will also get contaminated with those heavy metals. Hence, the eminent concentrations of heavy metals in spinach can be ascribed to the noxious waste in irrigation water, soil or industrial and vehicular emanation[49].

Conclusion

The ever increasing anthropogenic contamination which includes the addition of manures, sewage sludge, fertilizers and pesticides to soils, have identified as the risks in relation to increased soil metal concentration and consequent plant uptake in various studies conducted in the past. Spinach samples collected from Dahisar showed concentrations of Cu, Pb and Zn far higher than the WHO recommended permissible limit. Cr was found to be more than WHO limit in spinach sample collected from Dahisar, Mira road and Bhayandar. Remaining metals were found to be in permissible limit. As spinach is one of vegetables in high demand in market because they are part of day-to-day meal, persistent consumption of these contaminated leafy vegetable will certainly result in severe health consequences. Therefore, a continuous monitoring and evaluation of heavy metal concentration in Spinach as well as other green leafy vegetables is required.

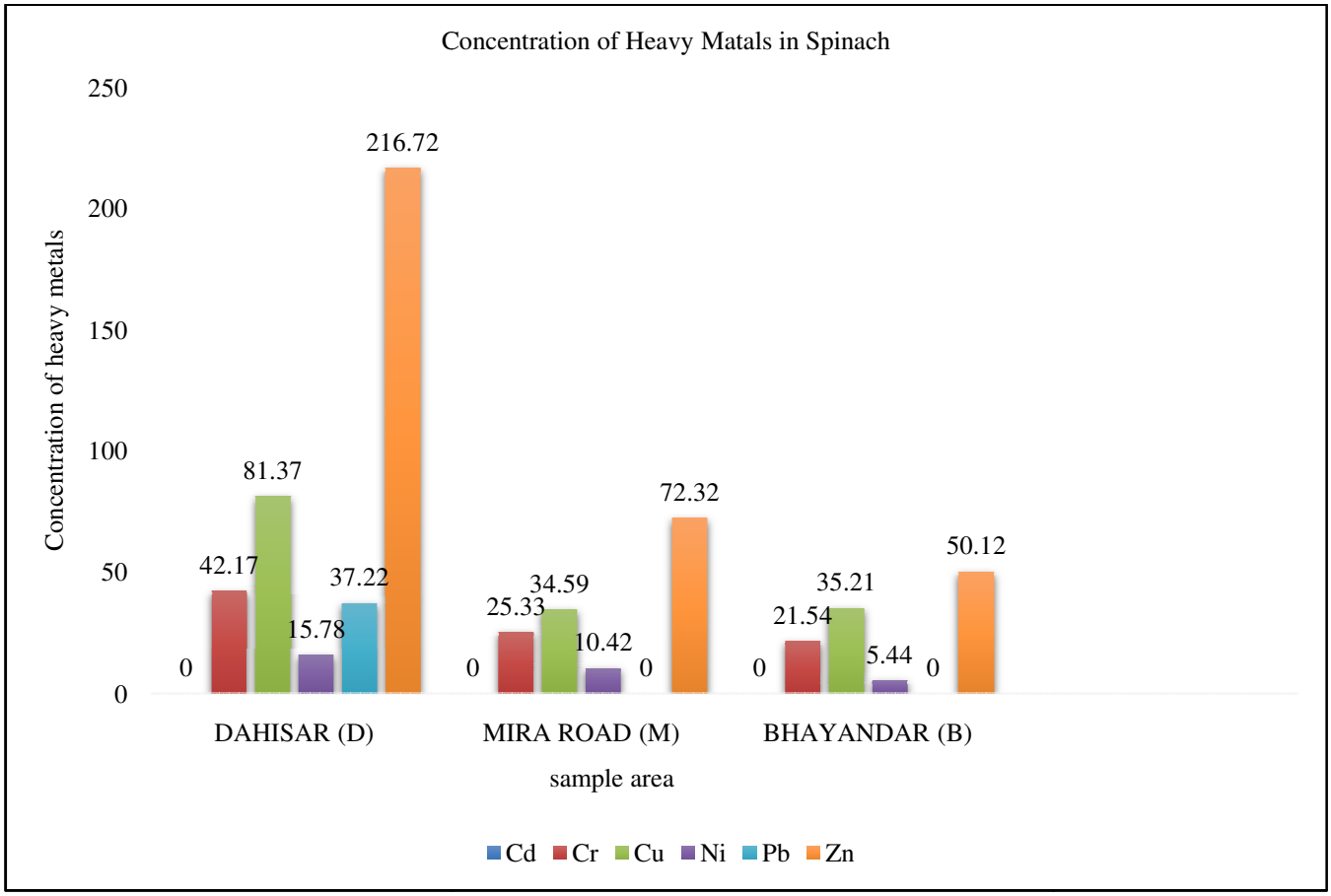

Figure-1: The levels of concentration of heavy metals found in Spinach in ppm from Dahisar, Mira Road and Bhayandar.

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