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Assessing the Impact of Heavy Metal Exposure in Green Leafy Vegetables in Singrauli District of Madhya Pradesh, India

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Abstract: - The green leafy vegetables such as Brassica (*Brassica campestris*) and Cabbage (*Brassica oleraca*) randomly collected from market and from agricultural fields in and around Singrauli city were analyzed for heavy metals Fe, Zn, Cd, Cr, Cu and Pb. Nearly 18 % samples of Palak from market had high level of Cd than the permissible limit of 1.5 mg/kg. 25 % sample of Brassica had high Pb and 27 % sample of Cabbage had high Zn than the permissible limit of 2.5 mg/kg. as per Indian standard of Food adulteration act. Heavy metals in the randomly collected samples were in the order of Fe > Zn> Pb>Cu>Cd where as in vegetables collected from agricultural fields around Singrouli City were in the order of Zn > Pb > Cu > Fe>Cd. The metal content in vegetable from agricultural areas indicate high level of soil contamination and accumulation of Pb and Cd in vegetable.

Keywords: - *Heavy Metals, Palak, Yellow Sarson and Cabbage*

I. INTRODUCTION

Metal contaminated soils are potentially harmful to plants, animal and humans. Toxic substances such as heavy metals have increased in Natural water and agriculture soils particularly in industrialized areas. Atmospheric deposition of heavy metals in soil and or in vegetables growing near industrial areas have been investigated[(1)] which indicate high concentration of heavy metals in leafy vegetables. Majority of soil contamination is through atmospheric deposition of heavy metals from sources such as metaliferous mining, smelting and other industrial activities. The heavy metals being immobile get accumulated in the soil endangering crops and vegetable[(2)].

Potential risk to population subgroups living on an consuming vegetables grown on large urban sites were assessed and was considered that young children are highly exposed[(3)]. The potential cancer risk from Cd and Ni are adzdressed as a result of occupational inhalation exposure[(4)].

Heavy metals may enter the body through inhalation of dust, direct ingestion of soil and consumption of food plant grown in metal contaminated soil[(5,6)]. Potentially toxic metals are also present in commercially produced foods stuffs[(7)]. Exposure to potentially toxic metals form dust inhalation or soil ingestion is usually modeled simply as the concentration of a contaminant measured in the soil multiplied by the quantity of dust inhaled or soil digested[(8)]. Municipal sludge is a valuable organic manure and soil conditioner and has been used as a fertilizer over decades but at the same time sludge may contain heavy metals and organic pollutants, which are harmful to crops and microorganism in soil therefore in current investigation metal analysis was carried out in randomly collected fresh samples of green leafy vegetable such as Brassica *(Brassica campestris)* and cabbage *(Barassica aleracea)* from vendors and agricultural filled.

II. MATERIALS AND METHODS

2.1 Collection and Preparation of Leafy Vegetable Sample :

A total of 45 vegetable samples were collected from places in and around Singrauli disttrct of M.P. during the period from February to April 2012 to assess the heavy metal contamination. The samples procured form market and agricultural filled included Brassica and Cabbage Vegetable samples were collected and then washed with running tap water to remove soil and dirt followed by distilled water. All samples were dried at 70^0

C for about 48-72 hours, then cooled to ambient temperature, crushed by means of a pestle and mortar and sieved. The sieved samples were stored in airtight sealed plastic bags until required for analysis.

2.2 Determination of heavy meals in Leafy Vegetables

One gram oven dried sieved sample was digested by wet digestion method with concentrated HNO_3 (15 ml.) and $HClO_4$ (5 ml.) in the ratio 3:1[(9)]. The samples were digested on a hot plate at a temperature corresponding to 100^0 C for 3-4 hours heating was done till it dried up completely and whitish brown dry mass was obtained.

It was then cooled and the precipitate/digest mixture was extracted in acid water mixture (Concentrated HCl : distilled water in the ratio 1:1) and filtered through whatman filter paper no. 42, valume was made up to 50 ml. The filtrate was analyzed for metal content using atomic absorption spectrophotometer. The instrument was calibrated using standard solution of Cr, Fe, Ni, Pb, Zn and Cd. The various metals along with their sensitivity limit (µg ml^{-1}) are as follows- Cr : 0.05, Fe : 0.05, Ni : 0.04, Pb : 0.06, Zn : 0.008 and Cd : 0.009.

III. RESULT

3.1 Metals in random samples of green leafy vegetables:

In randomly collected samples of Palak *(Beta vulgaris)*, Cabbage *(Brassica oleracea)* and yellow sarson *(Brassica campestris)* from 45 different vendors within the city of Waidhan and Morba heavy metals Fe, Zn, Pb, Cr and Cd analyzed showed great variation (Fig, 1). In Palak Zn varied from 25 to 68.88 mg/kg., Cd varied from 0.23 to 3.45 mg/kg., Fe varied from 6 to 12.8 mg/kg. Where as Cr and Ni were below detection limit in all the vegetables analysis showed that the trend for the heavy metals in Palak samples was in the order Fe>Zn>Pb>Cu>. In cabbage Fe ranged from 0 to 3928 mg/kg., Zn varied form 2.3 to 59.9 mg/kg., Pb was from 0.05 to 5.6 mg/kg., Cd was from 1.06 to 6.98 mg/kg. Where as Cr and Ni were below detection limit in all and the trend was Fe>Zn>Pb/Cu>Cd. In yellow sarson Cd ranged from 0.89 to 37.8 mg/kg., Zn from 27 to 70.2 mg/kg., Fe was from 1.08 to 45.2 mg/kg., Pb was from 9.3 to 51 mg/kg. Where as Cr and Ni were again below detection limit in all the samples.

Amongst the various heavy metals analyzed for different green leafy vegetables is similar trend in metal content was observed i.e. Fe>Zn>Pb>Cu>Cd, however their values in all vegetables were different. Fe was found highest in Palak with a mean of 24 ± 3.5 mg/kg. followed by cabbage with a mean of 17.45 ± 3.3 mg/kg. as yellow sarson as 17.35 ± 3.3 mg/kg, Zn was highest in yellow sarson with a mean of 35.6 ± 4.03 mg/kg. followed by Palak with a mean of 24 ±.5 mg/kg. and Cabbage having 16.3 ± 5.04 mg/kg. Cd was highest in Cabbage with a mean of 23.5 ± 66 mg/kg. followed by Palak with mean of 18.75 ± 5.3 mg/kg. and minimum in Brassica i.e. 17.35 ± 3.3 mg/kg. Cu was maximum in case of Palak with a mean of 56.25 ± 5.5 mg/kg. followed by Cabbage with a mean of 5.3 ± 0.52 mg/kg. and 3.95 ± 0.37 mg/kg. was for yellow sarson which was least.

3.2 Metals in random samples of green leafy vegetable collected from agricultural filed :

Vegetables were collected from different agricultural field around Singrauli city to study the metal concentration in the fresh farm produce fig. (II). In yellow sarson maximum concentration of Fe was found in sample of village Tamai (44.48 mg/kg) where as lowest concentration was reported in sample from village Judi (2.5 mg/kg) Cd concentration was highest in sample from village Bilaungi (37.8 mg/kg) followed by samples from Tamai (8.99 mg/kg) and village Madhauli (1.44 mg/kg) where as lowest concentration was reported in sample from village Judi (1.2 mg/kg.). Zn was maximum in sample from village Tamia (422 mg/kg) followed by sample from Judi and Madhauli villages (44.8 mg/kg and 53.4 mg/kg). Cu was maximum in sample from village Tamai (82.2 mg/kg) and minimum in samples from Judi village (2.5 mg/kg). Pb was maximum in samples from village Tamai (171 mg/kg) where as lowest was reported in samples from Bilaunji (3.26 mg/kg). Analysis trend showed that the order of metal content in Brassica was Zn>Pb>Cu>Fe>Cd.

Palak had maximum Fe concentration in samples from Tamai (23.36 mg/kg) followed by samples from village Judi, Madhauli and Khutar (7.77 mg/kg, 7.76 mg/kg and 3.7 mg/kg) respectively. Cd was maximum in sample from village Tamai (6.45 mg/kg) followed by sample from village Khutar (0.6 mg/kg) and Madhauli (0.55 mg/kg). Zn was maximum in village Tamai (247 mg/kg) followed by village Khutar (95.2 mg/kg) and Madhauli (47.78 mg/kg), Pb was reported to be maximum in village Tamai (82 mg/kg) followed by village Balaunji, Khutar and Judi (27.78 mg/kg, 17.66 mg/kg and 10.16 mg/kg) respectively. Cu was maximum in sample from village Tamai (40.12 mg/kg) followed by Bilaunji (16.86 mg/kg) and Khutar (6.2 mg/kg) trend in metal content was Zn>Pb>Cu>Fe>Cd.

Cabbage had Showed maximum Fe concentration in sample from village Judi (7.85 mg/kg) followed by Tamai (6.77 mg/kg) and Madhauli (4.56 mg/kg). Zn was maximum in sample from village Judi (47.42 mg/kg) followed by village Bilaunji 28.79 mg/kg) and village Madhauli (27.16 mg/kg). Cd was highest in

sample form village Bilaunji (0.66 mg/ks) followed by village Tamai (0.3 mg/kg) where as in other villages like Judi, Khutar and Madhauli it was bellow detection limit. Cu was maximum in samples from village Judi (16.4 mg/kg) and minimum in sample from Madhauli (8.3 mg/kg). Pb was reported to be maximum in village Judi (60.5 mg/kg) followed by sample from village Tamai (34.85 mg/kg) and village Khutar (30 mg/kg) trends observed in the heavy metal content was Pb>Zn>Cu>Fe>Cd. The study showed that the concentration of metals in different samples form different villages were different, indicating varied metal uptake. In all vegetables from different places it was formed that village Tamai had high concentration of Fe, Zn, Cu and Pb, samples from village Bilaunji had higher concentration of Cd whereas Cr and Ni were below detection limit.

IV. DISCUSSION

The rsult indicate that the metal content in the randomly collected samples of Brassica, Cabbage and spinach (Palak) were in the order of Fe>Zn>Pb>Cu>Cd, Where as in vegetable collected from agricultural filled around Waidhan city the order of metal content in general was Zn>Pb>Cu>Fe>Cd. The metal content in all the vegetable was above as defined by nutritiondata.com and elook.org, nearly 18 % samples of Palak from market had high level of Cd than the permissible limit of 1.5 mg/kg. 25 % sample of Brassica had high Pb and 27 % sample of Cabbage had high Zn than the permissible limit of 2.5 mg/kg as per Indian standard of food Adulteration Act.

The peak of the harvest was chosen keeping in consideration that the metal concentration in Plants varies with their age and season. A major cause for the occurrence of high content of metals in leafy vegetables is due to the presence of higher content of metals in the soil in which these vegetable are growing as these places were located near to industries and or high content is also due to irrigation by metal contaminated water released from the industries in the vicinity. A major pathway of soil contamination is through atmospheric deposition of heavy metals form point sources such as metalliferous mining, smelting and industrial activities. Other non point sources of contamination affecting predominantly agricultural soil are due to various inputs such as fertilizer, pesticides sewage sludge, organic manure, and compost **(10)**. Additionally foliar uptake of atmospheric heavy metals from emission gas also been identified as an important pathway of heavy metals contamination in vegetable crops. Several studies have shown that vegetable, particularly leafy crops, grown in heavy metal contaminated soil have higher concentration of heavy metals than those grown in uncontaminated soil **(11,12)**.

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