

Original Research Article

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Determination of Heavy Metals Contamination in Soil and Vegetable Samples from Jagdalpur, Chhattisgarh State, India

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ABSTRACT

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This study has been conducted to determine the concentration of heavy metals Lead (Pb), Cadmium (Cd), Copper (Cu) and Iron (Fe) in soil and some grown vegetables of Jagdalpur. (Bastar) Comparing the results of heavy metals in soil and vegetables by using Atomic Absorption Spectrometer, (Perkin Elmer A Analyst 400) double beam with their respective natural level. Fe concentration varied considerably in tomato and chilli are crossed permissible limits. Copper, Lead and Cadmium concentration are below than the safe limit. Overall, this study indicates that the soil and vegetables sample are contaminated by toxic heavy metals.

Introduction

Vegetables are widely used for culinary purpose and are very important in human diet because of presence of vitamins and minerals salts. They contain water, calcium, iron, sulphur and potash (Sobukola *et al.*, 2010).

They also act as neutralizing agents for acidic substances forming during digestion (Thompson and Kelly 1990).

Therefore fruits and vegetables are very useful for the maintenance of health as a preventive treatment of various diseases (D' mello, 2003). The presence of heavy metals may have a negative influence on the quality of vegetables and fruits causing changes to

their taste and smell. The term heavy metals to any metallic elements that has a relative density greater than 4gcm^{-3} . In the group of heavy metals one can distinguish both the element necessary for living organism and elements whose physiological role is unknown and those that are neutral for plants, animals and humans. Accumulation of heavy metals by vegetables may depend on plant species as well as temperature, moisture, organic matter, Ph, nutrient availability and concentration of heavy metals. The total concentration of heavy metals in soil and water however varies from local to regional and further to continental level. The uptake and accumulation of Cd, Cr, Fe were higher

during the summer due to high transpiration rate as compared to winters whereas Cu, Ni, Pb accumulated more in winter. Heavy metals exert toxic effect on soil. Metals are industrious natural contaminants, have long biological half-lives and potential for accumulation in different body organs leading to unwanted side effect. Metal toxicity in plants is aggravated at higher temperature and low pH as it facilitates the mobility from roots to shoots hence results in the change of the diversity population size and over all activity of soil microbial communities.

In Indian food tomato and chilli is the main ingredient for all diet. Heavy metals concentration may inhibit some vital plant processes i.e. photosynthesis, mitosis and H₂O absorption. The consumption of heavy metal contaminated food can seriously deplete some essential nutrients in body that are further responsible for decreasing immunological defenses, growth retardation disabilities associated with malnutrition and high prevalence of upper gastrointestinal cancer rates.

Materials and Methods

Study area

The study was conducted around Jagdalpur city of Bastar district Chhattisgarh during March 2017. This is one of the tribal districts of the state. Location of city is between 19.107 degree north latitudes and 81.953 degree east longitude. The district is located in southern part of of Chhattisgarh situated at the height of 2000 m above plateau MSL. Various small scale industries situated in this town. A large area around industries have less access to clean water resources, so farmer use treated and untreated waste water for irrigation. The hypothesis behind the present study is that the irrigation with waste water contaminates soil and environment and the

produce may elevate the levels of heavy metals in vegetable through surface deposition (Fig. 1).

Sampling

The soil sample and the edible portions of vegetables i.e. tomato and chilli were collected from Jagdalpur area. Randomly soils were collected from 6 fields of which 3 field having produce of tomato and 3 having chilli production. Soil samples were collected from two depths of 0-15 and 15-30 cm. The soil samples were oven dried at 40°C for 48 hours and then crushed with hammer and sieved by 2mm size. The vegetables were classified according to their common name and scientific name (Table 1).

Sample preparation and digestion

Vegetable samples were brought back to the laboratory and washed under clean tap water followed by double distilled water to eliminate soil and air-borne pollutants. After removing the extra water from the surface of vegetables with the help of blotting papers, samples were cut into pieces packed in separate bags and kept in oven until a constant weight was achieved. The dried samples were grinded and passed through a sieved of 2mm size and then kept at room temp for further analysis.

1.0 gram of dried sample was taken and then 5 ml of conc. HNO₃ was added and kept overnight. Next day 12 ml of di-acid mixture of conc. HNO₃ and HClO₄ in 3:1 ratio was added and digested on hot plate oven till the white reddish brown fumes comes out of the sample and the sample was evaporated till 2 ml was left in the flask. The resulting solution was cooled and filtered with Whatman filter paper 42. Finally volume of the extract was made up to 50 ml using double distilled water. 1.0 gram oven dried soil samples were

transferred in 100 ml beaker to which 30 ml of 3:1 ratio of conc HNO₃:HClO₄ was added. The mixture was kept in hot plate for 105°C for few hours till reddish brown fumes comes out and the sample was evaporated till 2 ml was left in the flask. The resulting solution was cooled and filtered with Whatman filter paper 42. Finally volume of the extract was made up to 50 ml using double distilled water.

Analysis

Concentration of heavy metals was carried out by using Atomic Absorption Spectrophotometer, (Perkin Elmer A Analyst 400) Double Beam and deuterium background hollow cathode lamps of Fe, Pb, Cd, Cu were used at specific wavelengths. All samples were run in triplicates.

Results and Discussion

The results of this study showed that the average concentration detected range from 0.2 to 5.75 mg/kg for given samples of vegetables and soil. The highest mean is of Cd, Fe, Cu and Pb respectively. The soil samples are contaminated by toxic heavy metals Fe concentration varied considerably in tomato and chilli crossed permissible limits.

Copper, Iron and Lead concentrations are below than the safe limit. Overall, this study indicates that the vegetables sample is contaminated by toxic heavy metals. The level of these metals found in our study is compared with those reported for similar vegetables from some other part of the world (Tabls 2 and 3).

Table.1 Scientific names of vegetables

Common name	Scientific name
Vegetable commodity	
Tomato	<i>Solanum lycopersicum</i>
Chilli	<i>Capsicum annum L.</i>

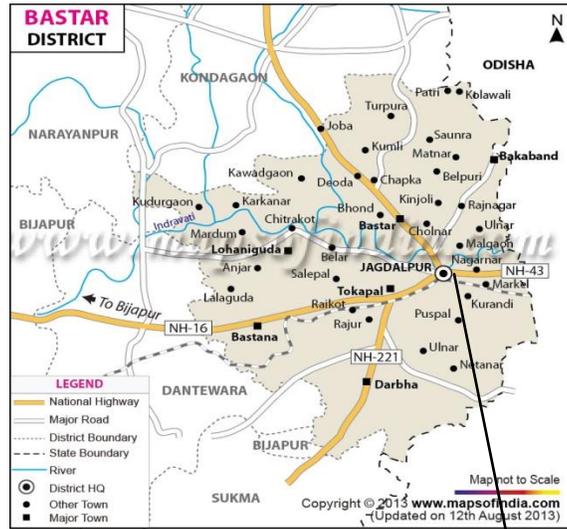
Table.2 Concentration of heavy metals (mg/kg or ppm) in vegetables

Commodity	Cu	Cd	Fe	Pb
Tomato (Site 1)	0.32	0.27	16.32	0.26
Tomato (Site 2)	0.41	0.77	8.427	0.2
Tomato (Site 3)	0.47	0.94	0.042	0.19
Chilli (Site 4)	0.14	0.02	11.4	0.32
Chilli (Site 5)	1.19	0.51	0.03	0.51
Chilli (Site 6)	0.6	0.2	9.65	0.92

Table.3 Concentration of heavy metals (mg/kg or ppm) in soil

Sampling Site	Cu	Cd	Fe	Pb
Site 1	0.42	0.77	19.32	0.76
Site 2	1.09	0.97	15.47	0.82
Site 3	1.17	1.74	12.42	0.99
Site 4	0.94	0.82	14.4	0.82
Site 5	1.59	0.71	14.93	0.71
Site 6	1.36	0.52	15.65	1.12

Fig.1 Map showing the sampling area



Study site

Fig.2 Represents the heavy metal concentration in the edible parts of vegetables of different sites

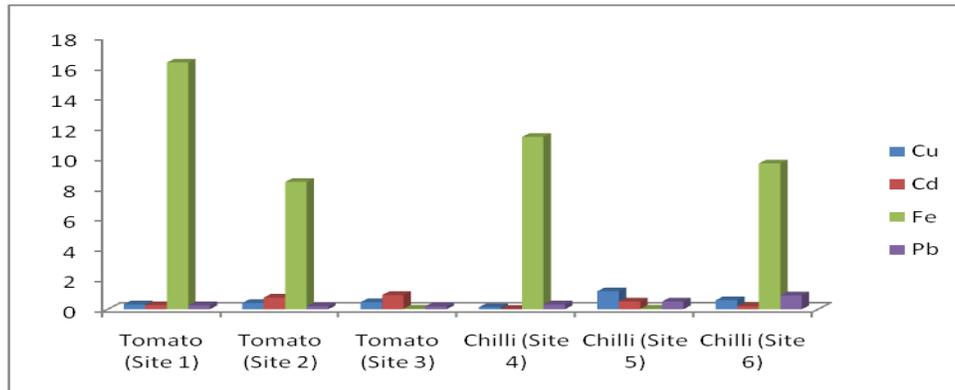
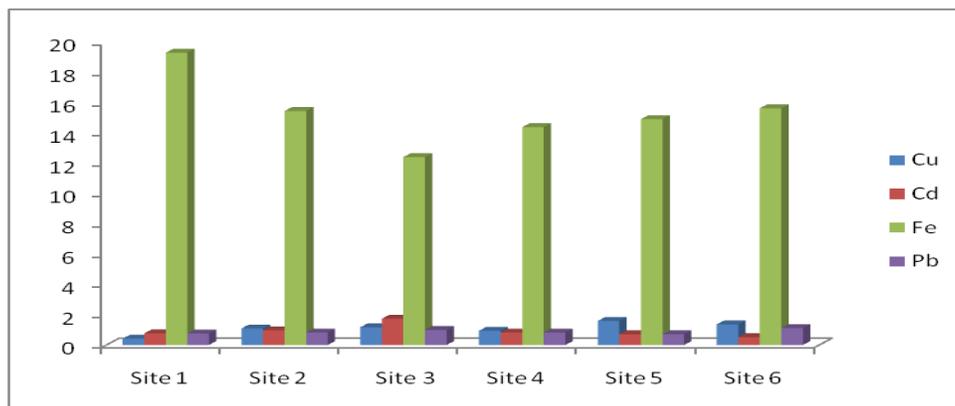


Fig.3 Represents the heavy metal concentration in different soils of Jagdalpur



From the given results it clears that Fe, Cu, Cd, Pb are present in the sample. These metals show toxic potential with injury to human health. The results of the present study showed that consumers are at lesser risk of consuming fresh vegetables with this level of heavy metals beyond permissible limits as defined by the Indian Prevention of food Adulteration Act 1954 (Figs 2 and 3).

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