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CADMIUM MONITORING AMONG SOME PLANT AND VEGETABLE SPECIES IN SINGRAULI REGION OF MADHYA PRADESH

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ABSTRACT

Thermal power plants produce enormous quantity of pollutants such as fly ash as a by - product of combustion of coal or any pulverized fuel at higher temperature. Industrial effluents contain several heavy metals including cadmium distrusted the metabolic process of living organism due to easily dispersion and mobilization in environment. The eatables and applicable potential plants and vegetables altered by Cadmium and concern derivatives which directly and indirectly posing severe risks to human health which, extremely toxic even in low concentration, and will bioaccumulate in organisms and ecosystems. Interest has therefore risen in its bio hazardous potential. Present study deals on monitoring or current status of cadmium in certain plant and common vegetable species in singrauli region, resulted indication were observed an alarming situation in Singrauli region of India.

INTRODUCTION: Cadmium is a relatively volatile element presence in live organisms including plants and animals is unwanted and harmful. It is non-essential elements that negatively affect plants growth and development. Cadmium is recognized as an extremely significant pollutant due to its high toxicity and large solubility in water [1]. An increased level of cadmium in air, water and soil raises its uptake through live organisms and eatable growing sources [2].

It is taken up by plants and animals through them also by humans. This leads to the cadmium cycle soil - plant - animal - man. In general, cadmium has been shown to interfere with the uptake, transport and use of several elements (Ca, Mg, P and K) and water by plants [3].

The documented information stated that up to 90Vo Cd taken up by plants originates from soil and only 10Vo from the surrounding [4]. Uptake of cadmium by plants and vegetables occurs through roots and leaves from water and soil only in the form of cadmium ion (after release from the sorption complex or from soil solution). Additional cadmium is transported to roots by diffusion and mass soil flow. The green plants are starting link of the food chain, which is the principal source of cadmium for animals and humans. They also accumulate unwanted substances including cadmium via pollutant releases by industries, mines and thermal power plants.

Green plants are consumed mostly by herbivores, which then become a source of food for carnivores [5]. The highly entry of cadmium in plants and vegetables is directly concern to industrialization. In industrial scenario, Singrauli is a prime district of Indian state of Madhya Pradesh emerging as India's energy capital covered coal mine, electricity generation power plants, and dense forests.

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Eastern part of Madhya Pradesh and adjoining southern areas of Sonbhadra district of Utter Pradesh state are collectively known as Singrauli region. Populations around 185,580 were calculated as per the current census 2011 with 85/km^2 (220/sqm) density. Energy generating industries like Singrauli Super Power Plant (SSPP), Vindhyanchal Super Thermal Power Plant (VSTPP), Northen Coal Limited (NCL), Kanoria Chemicals are regularly increases the quantity and types of pollutions via disposing of organic, inorganic, degradative and non-degradative waste materials in local environment which directly and indirectly affect the human health.

Modern civilization and prolonged discharge of industrial effluents, industrial sewage and solid waste dump cause the air and ground water pollution to created health troubles [6]. Both water and air is the most imperative component of eco-system, any imbalance, physical or chemical alterations beyond permissible limit would be harmful for eco-organization [7]. The mining and power plants operation created air pollution in terms of ash and dust. Pollutant containing fly ash as a solid waste produced in large quantities during burning of coal contains toxic elements such as Barium, Copper, Molybdenum, Zink, Beryllium, Cadmium, Selenium, Lead, Mercury etc. Besides these, several other metals are also present in traces amount [8].

Mostly heavy metals interact with soil, undergoes several changes in their forms. Part of element gets dissolved in water and become available for plants and vegetables to created health risk or toxicity (Neurotoxicity, hepatotoxicity, nephrototoxicity) produced via absorption and accumulation process of toxicants [9]. They all have in common is that only their absence can eliminate the respective health risk. Therefore it is very essential to recognize the problems and take appropriate early measures. Dietary sources account for most of human exposure to cadmium except for areas in the vicinity of cadmium emitting industries. Cadmium is taken up by roots of plants and passes to edible leaves, fruits and seeds. It will also accumulate in animal milk and fatty tissues.

In the present study, we investigated or analyzed the concentration of cadmium in plants and common used vegetables in air and water polluted Singrauli region.

MATERIAL AND METHODS:

Collection of samples and Soil pH determination: The study objects were the leaves of 6 basic arboreous species plant samples of (*Syzygium cumini, Dalbergia sissoo, Dandrocalamus strictus, Magnifera indica, Tectona grandis, Azadiracta indica*) and specimens of 5 common vegetable species *(Spinacia olaracia, Solanum tuberosam, Raphanus sativus, Brasica comprestis, Trogonella fonium)* which are the widely cultivated in numerous private home-gardens and farms within different area of Singrauli. Random sampling was done from 200 points all over the region. The sample leaves were carefully collected, labeled and stored accordingly. The pH of the bulked soil near the collected plant and vegetables sampling areas was determined using the electronic method.

Washing and Grinding of samples: After collection, the samples were brought to the laboratory and processed for further analysis. Samples leaves of plants and vegetable were properly separated and washed to remove dust particles. Samples were then chopped into small pieces using a knife. Vegetables and plant leaves were air-dried and then dried in an oven at 35 °C. Dried samples were grinded into a fine powder (80 mesh) using a mechanical electrical blender and stored in sterilized poly bags, until used for acid digestion with labeling.

Acid digestion and analysis of cadmium: Heavy metals in arborous species of plants and vegetable samples were extracted following acid digestion procedure in which 1g of the dry weight of each sample were taken in acid digestion test tube and 10ml of 98% nitric acid was added.

Further it was placed in water bath and allowed to boil for about 72 hours. Digestion was completed, with pale yellow color. A solution was makeup to 25ml with de-ionized water and stored in cool place. The prepared samples solution were analyzed for Cadmium using atomic absorption spectrophotometer (AAS, Perkin Elmer model 1100 B).

A certified standard reference material was used to ensure accuracy and the analytical values were within the range of certified value. Blank and standards were run after five determinations to calibrate the instrument.

RESULT AND DISCUSSION:

Cadmium in Plants Samples: The results of analyzed leaf samples of different plants species in Singrauli region have been recorded (**Table 1 and 2**).

TABLE 1: CONCENTRATION OF CADMIUM IN PLANTS

Sampling station code	Sampling Station	Sample code	Plants	Mean of Cd (µg/gm)
SPCD-A	Near Kanoria Chemicals	SPCD-A1	*Syzygium Cumine*	1.52
		SPCD-A2	*Dalbergia Sessoo*	1.32
		SPCD-A3	*Dandracalamus Strictus*	1.54
		SPCD-A4	*Magnifera Indica*	1.18
		SPCD-A5	*Tectona Grandis*	1.29
		SPCD-A6	*Azadiracta Indica*	1.23
SPCD-B	Near SSTPP*	SPCD-B1	*Syzygium Cumine*	1.75
		SPCD-B2	*Dalbergia Sessoo*	1.62
		SPCD-B3	*Dandracalamus Strictus*	1.65
		SPCD-B4	*Magnifera India*	1.11
		SPCD-B5	*Tectona Grandis*	1.42
		SPCD-B6	*Azadiracta Indica*	1.32
SPCD-C	Near VSTPP*	SPCD-C1	*Syzygium Cumine*	0.92
		SPCD-C2	*Dalbergia Sessoo*	1.56
		SPCD-C3	*Dandracalamus Strictus*	1.23
		SPCD-C4	*Magnifera India*	1.14
		SPCD-C5	*Tectona Grandis*	1.17
		SPCD-C6	*Azadiracta Indica*	1.33
SPCD-D	Near Waidhan City	SPCD-D1	*Syzygium Cumine*	0.12
		SPCD-D2	*Dalbergia Sessoo*	0.72
		SPCD-D3	*Dandracalamus Strictus*	1.64
		SPCD-D4	*Magnifera India*	1.13
		SPCD-D5	*Tectona Grandis*	1.12
		SPCD-D6	*Azadiracta Indica*	1.45

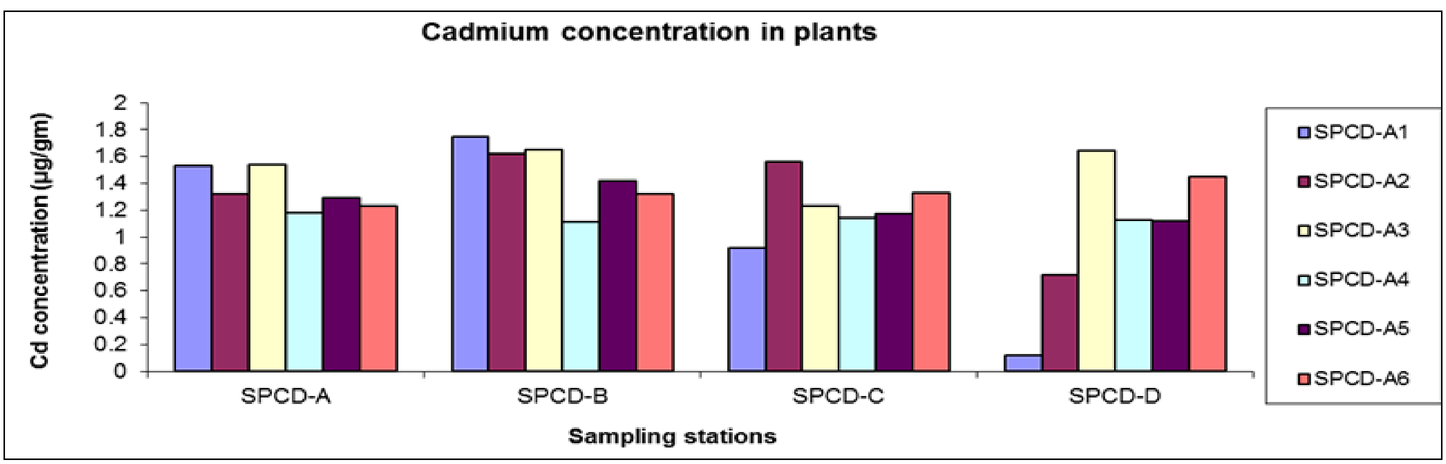

FIGURE 1: CADMIUM CONCENTRATION IN PLANTS

Almost 40 samples of *Syzygium cumini* from polluted area of Singrauli region were collected and found that cadmium level in Kanoria chemicals area was maximum 1.52µg/gm whereas the SSTPP and VSTPP samples were gave a higher concentration of cadmium 1.75µg/gm and 1.56µg/gm respectively. Similarly covered areas of Waidhan city were shown lowest concentration of cadmium.

The results clearly indicated that cadmium released through industrial effluent containing other more contaminant as compared to released effluents through power plants. In screened plant *Dalbergia sissoo* is widely distributed in forest, open lands and farms of this region. Cadmium with higher concentration were recorded 1.62µg/gm near SSTPP area's while lowest 0.72µg/gm cadmium concentration was analyzed near Waidhan city sampling station. In *Dandrocalamus Strictus*, presence of cadmium has been detected 1.64µg/gm in polluted region. Results indicating that bamboo plantation are not affected by cadmium pollution in that area.

Cadmium is a trace element with unknown essential functions for plants including bamboo plant. The short leaves of these plants is not fully observed the dust based pollutant but the elemental cadmium and other associated heavy metals were found on the both surface of bamboo leaves under accumulated and disperse condition. Mostly cadmium is, however, readily absorbed by plant roots and trans- located to above-ground parts to create changes in the growth and oxidative metabolism [10]. The minimized surface area alters in adsorption and adhesion phenomena in case of fruits as comparison to plant leaves.

Concentrations of cadmium (dry weight-based) are typically highly encountered in plant having wide and rough leaves. The cadmium ions worked as mediator to directly link with free radical and reactive oxygen species [11]. *Magnifera Indica* (Mango) is abundantly present tree in Singrauli region. It is found in the wild in india and cultivated varieties have been introduced to other warm regions of the world. Leaves of mango tree get contaminated by cadmium in the range between 1.11-1.18 µg/gm as per analyzed data. The leaves of *Tectona grandis* are broad and susceptible for air pollution and species is found abundantly in this area.

Highest cadmium concentration on the leaves has been found near SSTPP area (1.42 µg/gm), while lowest cadmium concentration1.12 µg/gm observed in restricted area near Waidhan city. Cadmium concentrations in field grown crops and plants are usually negatively related to soil pH but the effects are often small or even insignificant [12]. A highly potential medicinal plant, *Azadiricta Indica* is very common in this region. Its stem leaves and fruits documented for medicinal values. Out of 40 samples cadmium concentration ranges in between 1.23-1.45 µg/gm. results shows that uptake of cadmium is not equivalent to other plants. Regular enrollment of cadmium with plants created genetic variations due to genotoxic and ecotoxic nature of cadmium in animals also [13-14].

It can alter the uptake of other essential minerals by plants through its effects on availability of minerals from soil, or through a reduction in the population of soil microbes [15] our finding suggested that the concentration of cadmium inhibit the uptake of minerals from soil due to binding ability of cadmium with other potential minerals which are directly concern with root xylem and folium of plants. Chlorosis, leaf rolls and stunting are the main and easily visible symptoms of cadmium toxicity in plants. Similar finding were observed and documented, potential stunting observed in leaves stem areas in plants.

Cadmium in common Vegetables: In Singrauli region, there has been a rich practice for growing vegetables. Due to industrialization many of the vegetable gardens and farms have been converted into industrial area, even then the vegetables are growing in urban and rural areas, which is in vicinity of the ash ponds, power plants, coal mines and industries. The site selected for vegetables cadmium analysis are near industrial area and ash ponds.

Present study was conducted in five common used leafy vegetables cultivated frequently for analysis purpose. The number of samples collected in between 10-50. Cadmium contents in each sample were analyzed in triplicates. In case of spinach, out of four sampling stations the cadmium contents were in range of 0.09-0.19µg/gm. Maximum cadmium concentration was recorded in VSTPP sampling station 0.19µg/gm while minimum value 0.09 µg/gm was accounted in sample collected from Near Waidhan City (**figure 2**). The potato leaves are being affected by cadmium concentration in the range of 0.10-0.23 µg/gm. Cadmium concentration was recorded 0.10 >0.15 >0.17 and 0.23, in which minimum value was obtain in Kanoria chemicals samples whereas near SSTPP samples was shown maximum value.

TABLE 2: CONCENTRATION OF CADMIUM IN COMMON VEGETABLES

Sampling station code	Sampling Station	Sample code	Vegetables	Mean of Cd (µg/gm)
SVCD-1	Near Kanoria Chemicals	SVCD-A1	*Spinacia Olaracia*	0.16
		SVCD-A2	*Solanum Tuberosam*	0.10
		SVCD-A3	*Raphanus Sativus*	0.04
		SVCD-A4	*Brassica comprestis*	0.16
		SVCD-A5	*Trigonella Fonium*	0.19
SVCD-2	Near SSTPP*	SVCD-B1	*Spinacia Olaracia*	0.11
		SVCD-B2	*Solanum Tuberosam*	0.23
		SVCD-B3	*Raphanus Sativus*	0.28
		SVCD-B4	*Brassica comprestis*	0.15
		SVCD-B5	*Trigonella Fonium*	0.09
SVCD-3	Near VSTPP*	SVCD-C1	*Spinacia Olaracia*	0.19
		SVCD-C2	*Solanum Tuberosam*	0.15
		SVCD-C3	*Raphanus Sativus*	0.21
		SVCD-C4	*Brassica comprestis*	0.25
		SVCD-C5	*Trigonella Fonium*	0.11
SVCD-4	Near Waidhan City	SVCD-D1	*Spinacia Olaracia*	0.09
		SVCD-D2	*Solanum Tuberosam*	0.17
		SVCD-D3	*Raphanus Sativus*	0.19
		SVCD-D4	*Brassica comprestis*	0.13
		SVCD-D5	*Trigonella Fonium*	0.21

* Shaktinagar Super Thermal Power Plant (SSTPP). * Vindhyachal Super Thermal Power Plant (VSTPP)

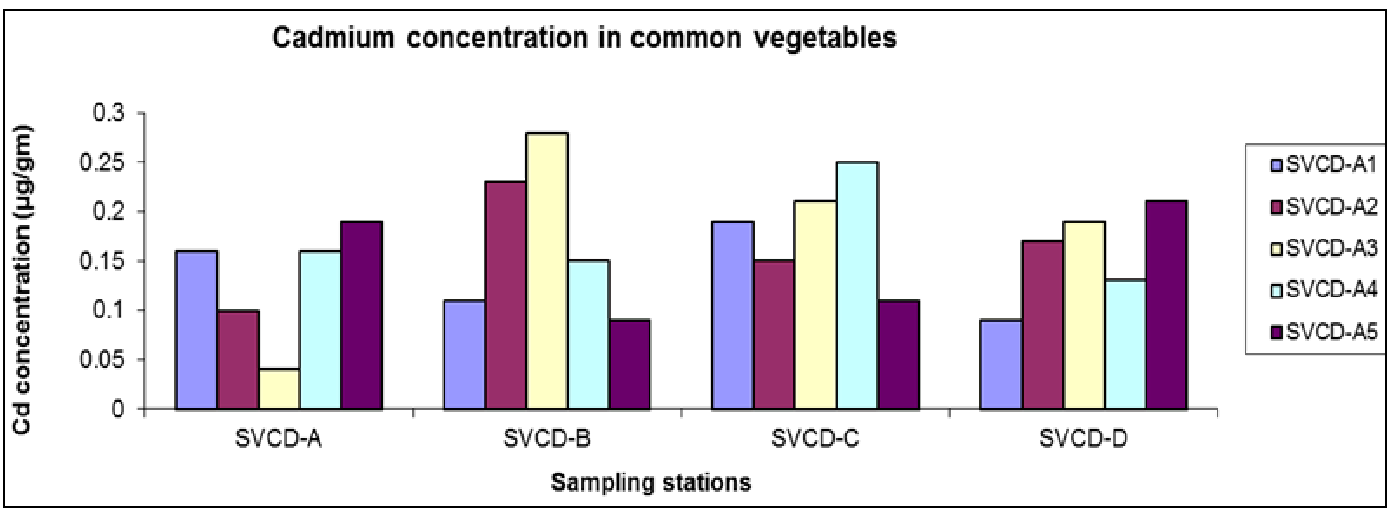

FIGURE 2: CADMIUM CONCENTRATION IN COMMON VEGETABLES

Soil salinity increases the cadmium uptake in field grown crops and vegetables [16-18]. Cadmium in radish has also been detected in the range of 0.04-0.23 µg/gm. Cadmium in mustard has been found to be in the range of 0.13-0.25 µg/gm. It is possible that mustard catch cadmium easily hence the uptake and transport is more as compared to other vegetables. Moreover, the roots of the vegetables also contained a concentration of heavy metals; the same trend in shoot was also notified. Some plant species there was higher concentration in the shoot than the roots. In case of fonium range of cadmium 0.09-0.21 µg/gm (figure 2) were recorded. This may also because of much susceptibility of cadmium with fonium.

The data suggested that the cadmium concentration is found to be more near ash areas, reason being that cadmium in ash of the areas takes a path through aquatic system which moves in soil, where cadmium gets transported in the plants through roots of vegetable. Another important possibility was also concern with pesticides treatment which may also be the causes of cadmium toxicity. Cadmium was higher accounted in aerial parts as compared to below the ground.

Observation resulted the cadmium comes through environmental air pollution which directly accumulated, observed and dispersed in aerial part of growing vegetable plant. Cadmium is highly mobile in nature, easily absorbed through soft root and moves to tissues and transfers to upper parts [19-22]. Direct relations have been exit between the presence level of cadmium in root and its absorption by plants [23-25]. Potentially toxic elements cadmium not easily chemically degraded or destroyed, it's affected the growth and quality of the leaf due to cadmium stress and its impacts on photo system II which affect the photosynthesis process of the plant.

CONCLUSION: The results of our investigation substantiate the conclusions. Cadmium from thermal power effluents absorbed in the surface of plants and vegetables leaves which creates toxicities with alteration on plants structures, photosynthesis, pigment production, growth and development etc. several environmental problems in terms of land degradation, ground, surface water contamination were also associated as results of toxicity of cadmium. The screen out and monitored plants and vegetables species having variable concentration of cadmium which unsafely affects to human health.

The present situation could however change in future depending on the dietary pattern of community and volume of cadmium contaminants added to the ecosystem. Although there is general tolerable level of cadmium at the moment and daily intake of it is less than the concentration. Elemental residues have raised serious setbacks and risks, which will persevere also in future. There is an effort to decline to a minimum or eliminate dispersion of contaminants into the food string and therefore also into the livings.

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