EVALUATION OF HEAVY METALS IN WATER, SOIL AND CAULIFLOWER IN PENAMALURU MANDAL IN VIJAYAWADA

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ABSTRACT

Anthropogenic activities are the leading cause of metal emissions to environment, often associated with high elevations in water, soil and plant metal concentrations. Heavy metals are bio-transferred and bio-accumulated by natural and anthropogenic sources. The contamination by heavy metals in food and water is one of the major problems observing throughout the world and alarming attention, because heavy metals above their normal ranges are extremely threatened to both plant and animal life. To assess the field conditions analysis was carried to estimate levels of heavy metals in water, soil and vegetable-cauliflower in and around Penamaluru Mandal in Vijayawada. Reports showed that the concentration of Cadmium, Chromium, Copper, Iron and Lead were above the permissible limits allowed by WHO and FAO. The Cauliflower curds contained much higher concentrations of heavy metals that could put the consumers of these vegetables at health risk with time due to bio-accumulation.

Keywords: Heavy metals, Cadmium, Chromium, Copper, Lead, Iron, Bio-accumulation.

Introduction:

Human activities like industrial production, agriculture and transport, release high amounts of heavy metals into surface waters, soils and ultimately to environment. Accumulation of heavy metals in crop plants is of great concern due to the probability of food contamination through the soil root interference. Though the heavy metals like Cd, Pb, and Ni, are not essential for plant growth, they are readily taken up and accumulated by plants in toxic forms. Several studies have indicated that the vegetables grown in contaminated soils have higher concentrations of heavy metals than the vegetables grown in uncontaminated soils (Guttomsen et al. 1995: downy and Larson 1995). Sources of contamination of heavy metals of agricultural soils include disposal of urban and industrial wastes, synthetic fertilizers, pesticides, sewage sludge and organic deposits (Singh 2001). Additionally, foliar uptake of atmospheric heavy metals emission has been identified as an important pathway of heavy metals contamination in vegetable crops (Salim et al.1992). Although some heavy metals such as Cu, Zn, Mn and Fe are essential in plant nutrition, many of them do not play any significant role in the plant physiology. The uptake of these heavy metals by plants is an avenue of their entry into the human food chain with harmful
effects on health (Ihekeronye & Ngoddy 1985). Municipal composts made of bio-
solids and yard wastes often contain higher concentrations of Cu, Zn, Cd, Cr and Ni
than those found in soils (He et al., 2001). The effect of pH on heavy metal availability
to plants has been reported by many researchers and it is accepted that as pH decreases
the solubility of cat ion forms of metals in the soil solution increases and therefore
they become more readily available to plants (Gray et al., 1998; Salam and Helmke,
1998; Oliveret et al., 1998; Singh et al., 1995; Evans et al., 1995; Filiuset al., 1998;
Mann and Ritchie, 1995;)

A large number of agricultural sites were located in Penamaluru Mandal of
Vijayawada. The Mandal lies on the banks of river Krishna. Rice, sugarcane, corn are
the major commercial food crops of this area. Cauliflower is the wide growing
vegetable crop in this zone. The Krishna river canal network is the major source of
irrigation in this area. There are reports of contamination that the canals receive
copious amounts of untreated sewage wastewater and solid waste from residence
houses and industrial waste waters along its course. The waste water management
practices in the city are very poor. This contaminated water from the canal system is
used extensively for irrigation in these areas. Hence, this poses significant effect on
the soil and vegetable crops thereby exposing the consumers of these vegetable crops
to bioaccumulation of the trace metals with time. This study is aimed at determining
the levels of some heavy metals in plant and soil samples.

Materials and Methods

One liter of water samples were collected in clean polyethylene bottles from
the selected areas of Bandar Canal of Krishna River passing through the Penamaluru
Mandal. The sample bottles were pre-treated with dilute nitric acid, dried and rinsed
with sample water and subjected for analysis and average values are reported. Soil
samples were collected in clean polythene bags from six selected sites of irrigated
farm lands of Penamaluru Mandal. The samples were subjected for analysis and average values are reported. Fresh Cauliflower curds were collected from the same
spots where the soil samples were collected and prewashed with distilled water to
remove soil and dust particles. The samples were air dried and subjected for analysis
with Fully Automated ICP Spectrometer and the readings were recorded.

Results:
Nickel (Ni): Nickel has been considered as an essential trace element for human and
animal health (Zigham and Hassan et al 2012). At small quantities it is necessary for
lipid regulations, but at larger quantities it becomes toxic. Nickel enters surface
waters by dissolution from rocks, soil and industrial wastes. Concentration of nickel
in water samples is measurable between 0.008mg/l to 0.029mg/l. In soil samples
nickel ranged between 30.6mg/kg to 69.3mg/kg and at soil sample 4 it was above the
permissible limits.

In all the Cauliflower samples there was no concentration of nickel found.
This may be due to non-accumulation character of nickel in vegetable plants.
Chromium (Cr): Chromium occurs naturally in many vegetables and fruits. Chemical industries are the major sources of chromium to surface waters. Concentrations of chromium in all the water samples are above the permissible limits, ranging from 1.32mg/l to 2.88mg/l. Concentrations of chromium in all the soil samples are above the permissible limits, ranging from 88.32mg/kg to 139.99mg/kg. Two of the cauliflower samples collected at site 3 and 4 showed the concentrations (4.199mg/kg and 6.321mg/kg) above the permissible limits. Chromium is a highly bio-magnifiable chemical in plants. At high concentrations it lowers ability to fight diseases.

Cadmium (Cd): Cadmium generally enters the environment through manures and pesticides. Household and industrial wastes are the major sources of cadmium to surface waters. Cadmium strongly absorbs to organic matter in soils and is extremely dangerous, as the uptake through food will increase. Concentrations of cadmium in all the water samples are above the permissible limits, ranging from 0.034mg/l to 0.151mg/l. Concentrations of cadmium in all the soil samples are above the permissible limits, ranging from 3.28mg/kg to 5.86mg/kg. All the cauliflower samples collected showed the high concentrations of cadmium than permissible limits.

Copper (Cu): Copper enters the environment both by natural and human activities like waste disposal and phosphate fertilizer manufacturing. Copper does not break down in the environment and because of this it can accumulate in plants and animals through soils. In human body copper accumulates in liver and brain. Concentrations of copper in all the water samples are above the permissible limits, ranging from 0.093mg/l to 0.25mg/l. Concentrations of copper in all the soil samples are above the permissible limits, ranging from 143.2mg/kg to 166.3mg/kg. Cauliflower samples collected at site 4 showed the high concentrations (39.19mg/kg) of copper than permissible limits.

Lead (Pb): Lead occurs naturally in the environment. However a human activity such as solid waste combustion is the major source of lead in soil and surface waters. Lead accumulates in the bodies of water and soil organisms. Soil functions are disturbed by lead interventions, especially near highways. Lead can accumulate in individual organisms and also in entire food chain. Concentrations of lead in all the water samples are above the permissible limits, ranging from 0.036mg/l to 0.083mg/l. Concentrations of lead in soil samples are above the permissible limits in three sample sites, ranging from 256.3mg/kg to 483.2mg/kg. Cauliflower samples collected at site 3 and 4 showed the high concentrations (3.99mg/kg and 4.62mg/kg) of copper than permissible limits.

Iron (Fe): Iron is the most abundant element in the earth crust. Industrial and domestic wastes are the major sources of iron in surface waters. Excess amount of iron causes rapid increase in pulse rate. Concentrations of iron in all the water samples are above the permissible limits, ranging from 0.391mg/l to 0.94mg/l. Concentrations
of iron in all the soil samples are above the permissible limits, ranging from 26.83mg/kg to 36.39mg/kg. The cauliflower samples collected at site 1 and 2 showed high concentrations (269.32mg/kg and 258.3 mg/kg) of iron than permissible limits.

**Zinc (Zn):** Zinc is a trace element that is essential for human health. Zinc plays a major role in physiological and metabolic process. Zinc occurs naturally in air, water and soil. Concentration of zinc in water samples is measurable between 2.39mg/l to 3.96mg/l. In the soil samples zinc ranged between 201.3mg/kg to 223.9mg/kg and is within the permissible limits. All the Cauliflower samples showed the less concentrations of zinc.

Table 1: Heavy metal concentration (mg/l) in Bandar canal water samples.

<table>
<thead>
<tr>
<th>Heavy metal</th>
<th>Name of the Sample collection sites</th>
<th>IS/FAO/WHO Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chodavaram</td>
<td>Pedapulipaka</td>
</tr>
<tr>
<td>Cadmium</td>
<td>0.034</td>
<td>0.041</td>
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<tr>
<td>Lead</td>
<td>0.09</td>
<td>0.036</td>
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<tr>
<td>Nickel</td>
<td>0.018</td>
<td>0.029</td>
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<tr>
<td>Zinc</td>
<td>3.125</td>
<td>2.39</td>
</tr>
<tr>
<td>Iron</td>
<td>0.67</td>
<td>0.94</td>
</tr>
<tr>
<td>Chromium</td>
<td>1.432</td>
<td>1.323</td>
</tr>
<tr>
<td>Copper</td>
<td>0.093</td>
<td>0.24</td>
</tr>
</tbody>
</table>

Table 2: Heavy metal concentration (mg/kg) in soil samples.

<table>
<thead>
<tr>
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<th>Name of the Sample collection sites</th>
<th>IS/FAO/WHO Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chodavaram</td>
<td>Pedapulipaka</td>
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<tr>
<td>Cadmium</td>
<td>3.281</td>
<td>3.91</td>
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<tr>
<td>Lead</td>
<td>201.9</td>
<td>256.3</td>
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<td>Nickel</td>
<td>40.15</td>
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<tr>
<td>Zinc</td>
<td>213.6</td>
<td>223.9</td>
</tr>
<tr>
<td>Iron</td>
<td>36.3</td>
<td>31.6</td>
</tr>
<tr>
<td>Chromium</td>
<td>96.8</td>
<td>88.3</td>
</tr>
<tr>
<td>Copper</td>
<td>143.2</td>
<td>165.1</td>
</tr>
</tbody>
</table>

Table 3: Heavy metal concentration (mg/kg) in Cauliflower samples, N.D (Not detectable)

<table>
<thead>
<tr>
<th>Heavy metal</th>
<th>Name of the Sample collection sites</th>
<th>IS/FAO/WHO Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chodavaram</td>
<td>Pedapulipaka</td>
</tr>
<tr>
<td>Cadmium</td>
<td>1.93</td>
<td>2.19</td>
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<tr>
<td>Lead</td>
<td>1.09</td>
<td>1.86</td>
</tr>
<tr>
<td>Nickel</td>
<td>N.D</td>
<td>N.D</td>
</tr>
<tr>
<td>Zinc</td>
<td>18.32</td>
<td>21.61</td>
</tr>
<tr>
<td>Iron</td>
<td>269.32</td>
<td>258.3</td>
</tr>
<tr>
<td>Copper</td>
<td>23.12</td>
<td>20.33</td>
</tr>
</tbody>
</table>
Discussion

Several studies were conducted to detect the environmental pollution and impacts of heavy metals all over the world. Specific studies on field level covering a large area of agriculture land which contributes the major mass of pollutants are not exhibited or not available for references. Practical difficulties in this may due to collection and analysis cost. Bio-accumulation of heavy metals in food chains through water and soil is a major issue facing at present in the world and requires attention. It was therefore of interest to conduct study to estimate the concentration of heavy metals in water, soil and major seasonal vegetable crop Cauliflower in Penamaluru Mandal villages of Vijayawada.

In the present study eight water samples were collected from Krishna River, irrigation canals in Penamaluru Mandal villages. The analysis report clearly showed the high concentrations of heavy metals like Cd, Cr, Fe and Pb in water. The reason for its extremity in values might b due to the addition of civic wastes and industrial effluents of the city discharging directly into the river. This clearly agrees with the studies (Zaigham Hassan et.al, 2012) who reported that the level of heavy metals increasing in the rivers due to discharge of industrial effluents and domestic pollution of various kinds. The soil samples analyzed showed the high concentrations of Cd, Cr, Fe and Pb than the permissible limits by WHO/FAO. High concentrations of Cd, Cr, and Cu in soil samples were in one way due to the excess use of fertilizers and pesticides without proper knowledge of application by farmers and in other way due to the use of manure prepared from non-segregated municipal solid waste or combustion waste.

High concentrations of Fe in soil samples were due to the natural occurrence of iron elements in soils. And high concentrations of lead may be because of farm lands located very nearer to National highway.

High concentrations of Cd, Cr, Pb and Fe in some samples of Cauliflower curds are due to bio-accumulation and bio-transformation natures of these elements from water and soil to plants. Slightly acidic pH levels in soils also effects and transfer these elements to plants.

Conclusion:

The data on environment and health risk assessment studies may be regarded as an aid towards a better understanding of the problem. Data on the occurrence of heavy metals and pesticides related illness among defined population in the developing countries are scanty (ICMR Bulletin, 2001). Therefore generation of descriptive data, based on area profiles are necessary to design and develop intervention strategies for periodic surveillance. The study results are indicative and more studies are required to analyze the temporal changes in the quality of irrigation water and the source of pollution. This study enable the researchers for further understanding of chemical and geographic factors that contribute to the knowledge of movement of residues from water and soil to plants.
Precautions:
1. The use of phosphate fertilizers is as per the dosage recommended by the Agricultural Department on the basis of soil testing.
2. The manure obtained from segregated municipal solid waste may be used.
3. Use of Green manures or compost should be encouraged.
4. Government should pay attention to improve water quality by banning the release of raw sewage water and solid waste into water bodies, so that soil is not polluted by heavy metals.

References:

