Health Risk Assessmet Of Alternanthra Sessilis Irrigated In Wastewater

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Abstract—
The present study assesses the health risk caused by heavy metals through the intake of alternanthera sessilis from waste water irrigated area. Heavy metals accumulation in soil and crops is of increasing concern because of the potential human health risks. The present study is aimed to compare and analyze the heavy metal concentration between soils and plants (Alternanthera Sessilis) from land irrigated with freshwater, waste-water, and treated water. Thus the result reveals that Pb, Cd, and Fe in waste water cultivated crops exceeded the permissible limits and the HRI was found out to be maximum. The crops cultivated out of treated water were out of risk. Thus the study reveals that the heavy metal accumulation in vegetables/crops irrigated with waste water will cause health effects to inhabitants.

Keywords— Alternanthera sessilis; *Daily intake; Health risk assessment; Heavy metalts.*

I. INTRODUCTION

The used water (waste water) for irrigation is increasingly being considered as a technical solution to reduce the water scarcity. Waste water contains substantial amounts of beneficial nutrients and toxic heavy metals, which are creating problems for crop production.

Wastewater may contain various heavy metals including Zn, Cu, Pb, Mn, Ni, Cr, Cd, depending upon the type of activities it is associated with. Continuous irrigation of agricultural land with sewage and industrial wastewater may cause heavy metal accumulation in the soil and vegetables.

Heavy metals are generally not removed even after the treatment of wastewater at sewage treatment plants, and thus cause risk of heavy metal contamination of the soil and subsequently to the food chain. Intake of heavy metals through the food chain by human populations has been widely reported throughout the world. Due to the non-biodegradable and persistent nature, heavy metals are accumulated in vital organs in the human body such as the kidneys, bones and liver and are associated with numerous serious health disorders. Individual metals exhibit specific signs of their toxicity. Lead, As, Hg, Zn, Cu and Al poisoning have been implicated with gastrointestinal (GI) disorders, diarrhoea, stomatitis, tremor, hemoglobinuria causing a rust-red colour to stool, ataxia, paralysis, vomiting and convulsion, depression, and pneumonia. The nature of effects can be toxic (acute, chronic or sub-chronic), neurotoxic, carcinogenic, mutagenic or teratogenic.

Some studies have been carried out for several decades to assess the health risk of heavy metals through consuming vegetables from wastewater-irrigated areas (Khan, Sajjad, et al., 2009; Singh, Anita, et al., 2010; Y.Z. Huang., et.al., 2010; Geetanjali Chauhan., 2014; S.M Rajendran., et.al 2014; Muhammad Imran.,et.al 2011).To our knowledge few studies have been carried out that have analyzed heavy metals in agro-products and evaluated potential health risks to inhabitants.

In the present study, the concentrations of heavy metals in locally produced CROP(alternanthera sessilis) were quantified through 6months at a rural area of Virudhunagar district of India, where treated and untreated wastewater has been used as a source of irrigation water. The contamination levels in soil and vegetable/cereal crops were evaluated with

respect to the prescribed safe limits of different heavy metals set under national and international norms. A number of standard measures were used to assess the health risks associated with the measured levels of heavy metal contamination at the study sites.

II. MATEERIALS AND METHODS

A.Study site

Agriculture land at chinnamanur village located in Theni district was selected as the study area. Three main zones were selected on the basis of fresh water, waste water and treated water irrigation. Fresh water site was irrigated using the clean water available in the well at the irrigation land area and waste water taken from municipal sewage. The third zone area is the treated water site where the municipal sewage is get treated and the water is used for irrigation.

B.Sample Collection

Soil & water sampling

Soil and water samples were collected by digging out, from three sites of Clean water, wastewater and treated water irrigated sites. Soil samples were air dried, crushed and stored at ambient temperature before analysis. The clean ,wastewater , and treated water samples (100 ml of each) used for irrigation were collected in bottle and 1 ml of concentrated HNO3 was added in the water sample to avoid the microbial activity.

C.Plant sampling

Alternanthera Sessilis crops were grown in the study area were collected from each site of sampling zone and stored in polythene bags and kept in laboratory. Hence, totally 3 types of samples were collected from each irrigation sites. Leaves of Alternanthera sessilis were then oven dried and ground into powdered form for digestion. 1 g of soil and powdered alternanthera sessilis samples were digested by 15 ml Tri acid mixture i.e. HNO3, H2SO4, HClO4 at 5:2:1 ratio until the transparent solution appeared. The tri acid mixture extraction was used for the heavy metal analysis. The heavy metals accumulated in soil, water and crops were determined by atomic adsorption spectrophotometer.

III. DATA VALIDATION

A.Enrichment factor

The metals from soil get transferred to the crops was determined as Enrichment factor (EF),

$$\mathbf{EF= C_{crops}/C_{soil}}$$

Where, C_{crops}= Concentration of heavy metals in crops
C_{soil} = Concentration of heavy metals in soil

B.Human Exposure Assessment

To assess the health risk of heavy metals, it is necessary to calculate the level of human exposure to that metal by tracing the route of exposure of pollutant to human body. There subsist many exposure routes for heavy metals that depend upon a contaminated media of soil and crops on the recipients. In the present study, metal concentrations in the collected crops were used to calculate the hazard index (HI).

$$\mathbf{Dose = C_{metal} \times D_{food\ intake} / B_{avg.\ weight}}$$

C_{metal}=concentration of heavy metals in food
$D_{food\ intake}$= Daily food intake
$B_{avg.weight}$= Average body weight
Hazard Index is the ratio of absorbed dose (exposure of heavy metals) to the reference dose (RfD)
HI<1 is an acceptable situation
HI>1 needs the heavy metal concentration to be decreased

HI=Dose/RfD

Rfd value for Zn, Pb, Cr, Cd, Fe, Mn and Cu is 0.2, 0.004, 1.5, 0.001, 0.02, 0.033 and 0.04 (mg/kg bw/day) respectively (US-EPA,2006).

IV. RESULTS & DISCUSSION

A.Physico-Chemical characteristics of samples

The physico–chemical characteristics of the clean water, wastewater and treated water which were used for the cultivation of the crops were analyzed and tabulated as below.

Table.1Characteristics of water

Sample water	Characteristics				
	pH	TS (mg/l)	TDS (mg/l)	TSS (mg/l)	COD (mg/l)
Clean water	8.3	122	122	-	-
Waste water	4.81	435	302	19	125
Treated water	6.8	161	154	14	56

B. Heavy metal concentration in soil and water samples

Heavy metal concentrations were determined by using Atomic Adsorption Spectrophotometer. Extraction made using tri acid mixture was used for the heavy metal analysis. Heavy metal concentration

in irrigated water at clean water zone, wastewater zone and treated water zone was analyzed and results were shown in the table.2.

Table.2Heavy metal concentration in soil and water samples

SAMPLES	Zn	pb	Cr	Cd	Fe
CLEAN WATER	bdl	0.036	bdl	0.0134	0.4
WASTE WATER	bdl	0.320	bdl	0.0143	0.006
TREATED WATER	bdl	0.0130	bdl	0.0100	0.005
CLEAN WATER SOIL	98.3	bdl	bdl	6.3	4600
WASTE WATER SOIL	0.76	155	bdl	14	3828
TREATED WATER SOIL	54.6	10.7	bdl	7.1	2756

The above table revealed that wastewater irrigated soil was enriched in Cd ,Pb and increased Fe values. Table shows the heavy metal concentration incrops

Table3.Heavy metal concentration in crops

SAMPLES	Zn	pb	Cr	Cd	Fe
FRESH WATER (Alternanthera Sessilis)	15.9	154.8	bdl	99.9	179.31
WASTE WATER (Alternanthera Sessilis)	62	234.15	bdl	134.8	543.06
TREATED WATER (Alternanthera Sessilis)	19	188.50	bdl	1.0175	372.26

*bdl – Below detecteable level

Mg and cu where below detectable level in the samples .

The Table.3 shows the concentration of heavy metals in alternanthera sessilis and Table.4 shows the enrichment factor of soil to crop.

The EF values were high in crops for Zn and Cd grown in wastewater zone.

Table.4Heavy Metal enrichment factor in crops

SAMPLES	Zn	Pb	Cr	Cd	Fe
FRESH WATER (alternanthera Sessilis)	0.161	0	Bdl	0	21.3
GREY WATER (alternanthera Sessilis)	81.5	0.99	Bdl	7.1	0.118
TREATED WATER (alternanthera Sessilis)	0.35	17.6	Bdl	0.143	0.135

Daily Intake of metals

DIM calculated for people exposed to the crops were presented in the table. These data revealed that the values of daily intake of metal were high for crops grown at Grey water zone comparing to the crops grown at fresh water zone.

Table 5.Daily Intake Metals

SAMPLES	DIM(mg/day/kg bw)				
	Zn	Pb	Cr	Cd	Fe
FRESH WATER (alternanthera Sessilis)	0.206	2.011	bdl	1.29	2.32
GREY WATER (alternanthera Sessilis)	0.805	3.042	bdl	1.751	7.055
TREATED WATER (alternanthera Sessilis)	0.24	2.44	bdl	0.013	4.836

The results arrived for DIM values it is clear that Chromium and Copper possesses low values and other metals such as Lead, Cadmium and Zinc carries high DIM values and hence their HI index would be increased due to high daily intake of those metals.

Hazard index

The hazard index of heavy metals in the alternanthera sessilis were tabulated in Table.6.In waste water zone the maximum HI were found for Spinach especially for pb and Cd. In fresh water and treated water zone shows high HI values for pb and Cd. Hence it is advised that an attention is required for the implementation of proper means to monitor and regulate the municipal effluents.

Table.6Hazard index of heavy metals

SAMPLES	Zn	Pb	Cr	Cd	Fe
FRESH WATER (alternanthera Sessilis)	0.68	1.087	bdl	5.087	0.345

GREY WATER (alternanthera Sessilis)	2.68	1.23	bdl	2.111	0.654
TREATED WATER (alternanthera Sessilis)	0.8	1.10	bdl	3.456	0.411

V. Conclusion

The alternanthera sessilis cultivated in freshwater, grey water and treated water were collected and analyzed for the heavy metals concentrations. The concentration of Pb and Cd shows major difference in the heavy metal accumulation for the crops cultivated in three different zones.The present study revealed that wastewater irrigated soil was enriched in Cd and Pb. These data revealed that the values of daily intake of metal were high for alternanthera sessilis grown at waste water zone comparing to the vegetables grown at clean water zone and treated water zone. HI of the study suggest that alternanthera sessilis pose severe health risk with regard to the pb and Cd.

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