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Research Article

ACCUMULATION OF HEAVY METALS (Ni, Cd, As, Pb, Zn, Fe) IN PLANTS IRRIGATED WITH INDUSTRIAL WASTE WATER COLLECTED FROM KOTA, RAJASTHAN

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ABSTRACT

Heavy metals contamination in plants and water is one of the major issues to be faced throughout the world and requires attention because bioaccumulation and biotransfer of heavy metals above their normal ranges are extremely threatened to both plant and animal life. Therefore studies were conducted to estimate levels of heavy metals in plants and water. Concentrations of some heavy metals were determined in *Cicer arietinum* and *Glycine max* plants which were irrigated with industrial waste water collected from Kota industrial area. Heavy metals for which these samples were analyzed were cadmium, zinc, iron, nickel, arsenic and lead. Flame absorption spectrometer was used for analyzing the samples. Results revealed that concentrations of cadmium, lead, iron and arsenic in water were recorded above the permissible limits set by World Health Organization (WHO) while zinc and nickel were recorded below the permissible limits in industrial waste water samples.

Concentrations of heavy metals in plant samples were also compared with WHO standards for heavy metals and in industrial waste water irrigated plant samples. Concentration of heavy metals in plant was recorded above the permissible limits except zinc and arsenic which was recorded below the permissible limits set by WHO.

INTRODUCTION

Human activities such as industrial production, mining, agriculture and transportation release high amounts of heavy metals into surface and ground water, soils and ultimately to the biosphere. Though the heavy metals like, Cd, Pb and Ni are not essential for plant growth, they are accumulated by plants in toxic forms. Intakes of vegetables irrigated with waste water and contaminated with heavy metals possess a possible risk to health of living being and wildlife. The main sources of heavy metals in the environment are activities such as mining, metal industry, chemical industry, vehicles, agriculture as well as domestic activities [L.Jantschi *et al* 2008, C, Stihi *et al* 2006](18).

This heavy metals accumulation may adversely affect soil ecology, crop production or product quality and ground water quality and will ultimately harm to health of living organism in the end. (1)

The use of processed wastewater for different purposes is one of the most important strategic alternatives for renewable water in many countries. The use of wastewater in agriculture provides water, Nitrogen, Phosphorous, and organic matter to the soil. However, concern about the accumulation of potentially toxic elements, such as Cd, Cu, Fe, Mn, Pb and Zn from both domestic and industrial sources is increasing (Devkota and Schmidt, 2000) (3). When the capacity of the soil to hold heavy metals is reduced due to the repeated application of wastewater, heavy metals leach into the ground water, which are then available for plant uptake.(2) There are minimal chances of heavy metal poisoning due to the ingestion of crop irrigated with industrial wastewater. (Kitagishi and Yamane, 1981). (5)Heavy metals contribute to environmental pollution due to their unique properties. They are non-biodegradable, non-thermo-degradable and generally do not leach from the topsoil. The duration of contamination by heavy metals may be for hundreds or thousands of years, even after their addition to soils had been stopped. (4)

Heavy metals are easily accumulated in the edible parts of leafy vegetables or crop, as compared to grain or fruit crops (Mapanda, Mangwayana, Nyamangara, & Giller, 2005)(7). Plants absorb water containing heavy metals and accumulate them in their edible (Bahemuka & Mubofu, 1991)(8) and inedible parts in quantities high enough to cause clinical problems to all living beings consuming these metal-rich plants

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(Alam, Snow, & Tanaka, 2003)(9). Many serious health issues can develop as a result of excessive intake of heavy metals in diet. Furthermore, the consumption of heavy metal-contaminated crops can seriously deplete some essential nutrients in the body causing a decrease in immunological defense mechanism, intrauterine growth retardation, impaired psycho- social behavior, disabilities associated with malnutrition and a high prevalence of upper gastrointestinal cancer.(6) Irrigation of crops with industrial wastewater is a very common practice in India and the effect of irrigation with such industrial wastewater on the crops to observe the concentration of accumulated metals to which human beings are exposed. The present study was carried on to examine the heavy metals (arsenic, nickel, cadmium, lead, zinc and iron) concentration in industrial waste water. The very common crops *Cicer arietinum* and *Glycine max* grown in the Kota region were selected to study heavy metals concentration in the plants irrigated with industrial waste water.

Study area

The district Kota lies between 24°25’ and 25°51’ North latitudes and 75°31’ and 77°26’ East longitudes with total area of 5767.97 Sq Km. “Kota City” is located at extreme South of it at 25°11’ North latitude and 75°51’ East longitude invading total area of 238.59 Sq Km with average height 253.30 meters from sea level. Kota is industrial town of Rajasthan with historical importance of its own. (10)

Many large and small scale industries are present in Kota. Few industries including DCM Shriram Consolidated Limited (DSCL), Multimetals Limited, Samtel Glass Limited, Chambal Fertilizers and Chemicals Limited (CFCL), Shriram Fertilizers and Metal India, Shriram Rayons and a number of Kota stone cutting and polishing units further enhance the heavy metal burden in the Atmosphere. Many industries are established due to availability of river water and power.(11)

MATERIALS AND METHODS

Experimental plant

***Cicer arietinum* L.**(Gram)(RUBL 211593)
***Glycine max* (L.) Merr.**(Soyabean)(RUBL211592)

Collection of plants and water samples

The study was conducted with waste water released from industries of Kota. Waste water samples were collected from common outlet point in Kansua nalla of combined effluents from industries of Kota. Effluent samples were collected in plastic container of 5-liter capacity. The seeds of *Cicer arietinum* and *Glycine max* were purchased from registered seed center. Four plots of 5× 4.5 m² size were prepared. Seeds of *Cicer* were sown in two plots. One plot was irrigated with tap water and named as control and other with industrial waste water. Similarly Glycine seeds were sown in other two plots. Uniform irrigation schedule was followed for all plots throughout the growth of plants. Names of the four plots were given as *Cicer* control, *Cicer* waste water, *Glycine* control and *Glycine* waste water plot. Plant samples collected from all four plots were washed with distilled water to remove dust particles. Samples were air dried and then grounded into fine powder, sieved and stored in polythene bags.

Experimental

Dry powdered crop samples were digested with HClO4, concentrated HNO3 and H2SO4. and used for metal determinations. (Erwin and lvo’s 1992)(12) The digested samples were analyzed for heavy metals (As, Cd, Fe, Ni, Pb and Zn) using atomic absorption spectrophotometer (AAS VGB 210 System). The instrument setting and operational conditions were done in accordance with the manufacturers’ specifications.

Observation Table

RESULTS AND DISCUSSION

Present study was conducted in order to assess the heavy metal contamination in water and plants irrigated with that contaminated water. As water pollution is dangerous for both plants and human health so it is the need of hour to assess the water quality as this is a very important issue related to human and environment.

Water

Water samples were collected and were analyzed for six heavy metals (As, Cd,Pb, Zn, Fe and Ni) using standard procedures.

Table 1

S No.	Heavy metals	Control water (mg/l)	Industrial waste water(mg/l)	WHO :1993 (mg/l)	IS 10500: 2012(BIS) (mg/l)
1	Arsenic(As)	0.0013± 0.002	3.074±0.004	0.01	0.01-0.05
2	Cadmium(Cd)	0.0019 ±0.002	0.634±0.002	0.003	0.003
3	Lead(Pb)	0.008±0.001	3.118±0.0015	0.01	0.01
4	Zinc(Zn)	0.182±0.02	2.586±0.030	3	5-15
5	Iron(Fe)	0.137±0.011	0.208±0.007	0.3	0.3
6	Nickel(Ni)	0.008 ±0.001	0.010±0.0015	0.02	0.02

Table 2

S. No.	Heavy metals	*Cicer* (control)	*Cicer* (industrial waste water)	*Glycine* (control)	*Glycine* (industrial waste water)	WHO (mg/l)
1	Arsenic(As)	0.009±0.001	0.011±0.001	0.006±0.005	0.016±0.002	0.01
2	Cadmium(Cd)	0.082±0.002	0.095±0.001	0.04±0.003	0.059±0.003	0.003
3	Lead(Pb)	0.212±0.002	0.436±0.002	0.286±0.003	0.551±0.002	0.01
4	Zinc(Zn)	0.326±0.002	0.527±0.001	0.377±0.002	0.480±0.002	3
5	Iron(Fe)	1.775±0.005	3.886±0.003	0.480±0.002	2.89±0.003	0.3
6	Nickel(Ni)	0.010±0.001	0.13±0.015	0.022±0.001	0.11±0.016	0.02

The mean concentrations of As, Cd, Pb, Zn, Fe and Ni in industrial waste water were 3.074±0.004 mg/l, 0.634±0.002mg/l, 3.118±0.0015mg/l, 2.586±0.030mg/l, 0.208±0.007mg/l and 0.010±0.0015mg/l respectively (table-1). The present study indicated that arsenic(As), cadmium(Cd) and lead(Pb) concentrations in industrial wastewater were higher than the permissible limits given by WHO and BIS. The Zn, Fe and Ni contents were under the permissible limits in industrial waste water sample. In control water mean concentration of As,Cd,Pb,Zn,Fe and Ni were all under WHO and BIS permissible limits.

Cicer arietinum

Levels of heavy metals in *Cicer* leaves irrigated with control water and industrial waste water are As 0.009±0.001 and 0.011±0.001 mg/l; Cd 0.082±0.002 and 0.095±0.001mg/l; Pb 0.212±0.002 and 0.436±0.002mg/l; Zn 0.326±0.002 and 0.527±0.001mg/l; Fe 1.775±0.005 and 3.886±0.003mg/l; Ni 0.010±0.001 and 0.13±0.015mg/l respectively (table :2)

The concentration of all heavy metals in Cicer plant irrigated with industrial waste water is higher than control water irrigated plants.

The concentrations of heavy metals samples were compared to the WHO guideline values that is As 0.01mg/l ; Cd 0.003mg/l ; Pb 0.01 mg/l; Zn 3 mg/l ; Fe 0.3 mg/l ; Ni 0.02mg/l ;. The result of this study showed that Cd, Pb, Fe and Ni concentration is found slightly higher in cicer plant leaves as compared to WHO permissible limits.

Glycine max

Levels of heavy metals in G*lycine* leaves irrigated with control water and industrial waste water are As 0.006±0.005 and 0.016±0.002 mg/l; Cd 0.04±0.003 and 0.059±0.003 mg/l ; Pb 0.286±0.003 and 0.551±0.002 mg/l ; Zn 0.377±0.002 and 0.480±0.002 mg/l; Fe 0.480±0.002 and 2.89±0.003 mg/l ; Ni 0.022±0.001 and 0.11±0.016mg/l respectively (table :2)

The concentrations of heavy metals samples were compared to the WHO permissible guideline values. The result of this study showed that Cd, Pb, Fe and Ni concentration is found slightly higher in *Glycine* plant leaves as compared to WHO permissible limits.

Cadmium more than the permissible limit (WHO,BIS) results for several health risks such as Cd in its higher concentration results Carcinogenic, painful Osteomalacia (bone disease), destruction of red blood cell and kidney damage, also affects several important enzymes problems. Pb (lead) is very toxic and has serious health problems even at low concentrations (Okoronkwo *et al*., 2005) (13). Ingestion of lead contaminated food cause mental retardation in children, colic anaemia and renal diseases. The accumulation of lead in plants is more pronounced at locations close to the emission source of lead vapours and fine particles (Abou-Arab *et al*., 2000)(14). Long term exposure result in decreased performance in the functions of the nervous system; weakness in fingres, wrists or ankles ; small increase in blood pressure and anaemia. Others effects are abdominal pain ,arthritis, attention deficit, back problems, blindness, cancer, constipation, convulsions, depression, diabetes, migraine headache ,thyroid imbalances and tooth decay (Lokeshappa *et al.*,2012).(15) (1) Iron in water is present as Fe^{2}† or Fe^{3}† in suspended form. It causes staining in clothes and imparts a bitter taste. It comes into water from natural geological sources, industrial wastes, domestic discharge and also from by products. Excess amount of iron causes rapid increase in pulse rate and coagulation of blood in blood vessels, hypertension and drowsiness. (1)

Nickel is considered as an essential trace element for human and animal health. [Zigham Hassan *et al* 2012](16). But high amount of nickel exposure can cause dermatitis. When ingested, in small amount, it is harmless to humans and infact necessary in our diet.(1)

Results revealed that industrial waste water used in the present study is not suitable for irrigation purpose because waste water samples contain high amount of heavy metals .The level of heavy metals in industrial waste water is higher than the permissible limits of Bureau of Indian Standards (BIS) and WHO. Reports of this study support elevated levels of heavy metals in edible parts of food crops with continuous waste water irrigation(khan *et al*,2007) ;(Liu *et al*, 2005)(17).

The reason for this extremity in values might be due to the addition of civic wastes and industrial effluents of the city directly discharged into the water bodies. This is in agreement with the studies (Zaigham Hassan *et al*., 2012) (16)who reported that the level of heavy metals is increasing in the rivers due to discharge of industrial effluents and civic pollution of various kinds. This in turn is deteriorating the water quality making it unsuitable for both plants and human life.

The concentrations of heavy metals determined in industrial waste water were in sequence Pb> As > Zn> Cd > Fe > Ni .So, waste water have highest and lowest concentration of lead and Nickel respectively. Whereas in *Cicer* and *Glycine* crops concentration of heavy metals in industrial waste water irrigated crop were in sequence Fe>Zn>Pb>Ni>Cd>As and Fe>Pb>Zn>Ni>Cd>As respectively. This shows that iron is accumulated in both crops in highest concentration and arsenic accumulation is minimum in both plant leaves.

CONCLUSION

Therefore we can conclude that crops grown by irrigation with the industrial waste water of Kota region accumulates heavy metals in their leaves and the level of heavy metals are more than the permissible limits given by WHO/BIS and crops are not suitable for eating and it may be harmful for people's health. So it is an urgent need to remove or prepare heavy metals free water in order to secure the metabolism in plants and human beings. An attempt has been made to study their accumulation in plants, which may be helpful in eradication of the problem.

References

1. Nazir.R., Khan.M., Masab.M., Rehman.H.U., Rauf.N.U, Shahab.S., Ameer.N., Sajed.M., Ullah.M., Rafeek.M., Shaheen.Z., Nazir.R., 2015. Accumulation of Heavy Metals (Ni, Cu, Cd, Cr, Pb, Zn, Fe) in the soil, water and plants and analysis of physico-chemical parameters of

soil and water Collected from Tanda Dam kohat. *J. Pharm. Sci. and Research*. 7(3): 89-97.

2. Balkhair K.S., Ashraf M.A., 2016. Field accumulation risks of heavy metals in soil and vegetable crop irrigated with sewage water in western region of Saudi Arabia. *Saudi Journal of Biological Sciences*.23:S32-S44.
3. Devkota B., Schmidt G.H., 2000. Accumulation of heavy metals in food plants and grasshoppers from the Taigetos Mountains, Greece. *Agric. Ecosyst. Environ*. 78: 85-91.
4. Amiri S. S., Maralian H., Aghabarati A., 2008. Heavy metal accumulation in *Melilotus officinalis* under crown *Olea europaea* L forest irrigated with wastewater. *African Journal of Biotechnology*.7(21):3912-3916.
5. Kitagishi K., Yamane I.,198. Heavy Metal Pollution in Soils of Japan. Japan Scientific Societies Press, Tokyo.3-15.
6. Arora M.,Kiran B., Rani S., Rani A., Kaur B., Mittal B.,2008. Heavy metal accumulation in vegetables irrigated with water from different sources Food Chemistry 111:811-815
7. Mapanda F., Mangwayana E.N., Nyamangara J., Giller K.E., 2007. Uptake of heavy metals by vegetables irrigated using wastewater and the subsequent risks in Harare, Zimbabwe. Physics and Chemistry of the Earth. 32: 1399-1405.
8. Bahemuka T.E., Mubofu E.B., 1991. Heavy metals in edible green vegetables grown along the sites of the Sinza and Msimbazi rivers in Dar es Salaam, Tanzania. *Food Chemistry*. 66: 63-66.
9. Alam M.G.M., Snow E.T., Tanaka A., 2003. Arsenic and heavy metal contamination of vegetables grown in Santa village, Bangladesh. Science of the Total Environment.308: 83-96.
10. Gupta N., Nafees S.M., Jain M.K., Kalpana S., 2011. Physio-chemical assessment of water quality of river Chambal in Kota city area of Rajasthan (India). *Rasayan Journal of Chemistry*.4(2): 686-692
11. Meena M., Meena B.S., Chandrawat U., Rani A., 2014.Chemical Characteristics of Rain Water at an Industrial City of Western India. *International Journal of Innovative Research in Science, Engineering and Technology*.3(7):14359-14367
12. Erwin J.M., Ivo N., 1992. Determination of Lead in tissues: A pitfall due to wet digestion procedures in the presence of sulphuric acid. *Analyst*. 17: 23-26.
13. Okoronkwo. E.A., Ebisike.K., 2010. Biosorption of copper and zinc from aqueous solution by bamboo biomass in batch and column studies. *Int. J. Biol. Chem. Sci*. 4(2): 314-326.
14. Arab A., A.A.K.; Donia A., M.A.,Enb., 2008.A chemical composition, metals content and pesticide residues in raw, pasteurized and UHT milk and their dietary intake. *J. Egypt. Soc. Toxicol*.39: 111-121
15. Lokeshappa B., Shivpuri K., Tripathi V., Dikshit A.K., 2012. Assessment of Toxic Metals in Agricultural Produce. *Food and public Health*. 2(1): 24-29
16. Hassan Z., Anwar Z., Khattak K.U., Islam M., Khan R.U., Khattak J.Z.K.2012. Civic Pollution and Its Effect on Water Quality of River Toi at District Kohat, NWFP. *Research Journal of Environmental and Earth Sciences*.4-5.
17. Liu W.H., Zhao J.Z., Ouyang Z.Y., Soderlund L., Liu G.H., 2005. Impacts of sewage irrigation on heavy metal distribution and contamination in Beijing, China. *Environ. Int*. 31 (6):805-812.
18. Stihi C., Bancuta A., Popescu I. V., 2006. Air pollution studies using PIXE and ICP methods. *Journal of Physics*. 41(1):565-568.

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