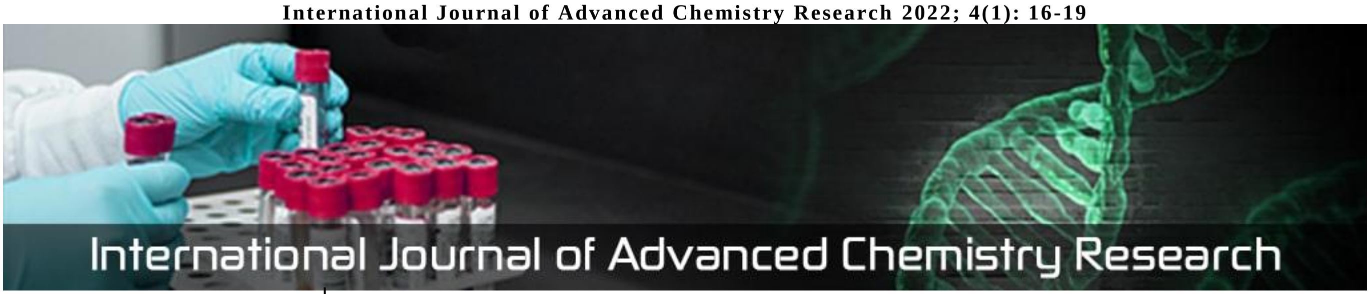
International Journal of Advanced Chemistry Research 2022; 4(1): 16-19



ISSN Print: 2664-6781
ISSN Online: 2664-679X
Impact Factor: RJIF 5.32
IJACR 2022; 4(1): 16-19
www.chemistryjournals.net
Received: 22-11-2021
Accepted: 24-12-2021

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Assessment of trace metal content in water, soil and vegetables samples in the vicinity influenced by industrial effluents

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DOI: https://doi.org/10.33545/26646781.2022.v4.i1a.42

Abstract

Pollution of the environment by trace metals emanating from rapid economic growth and improper waste and effluent disposal is a major concern. In this study trace metal concentrations, Cu, Zn, Pn, Ni, Sn, Cr, Fe, Co Mn and Cd in water, soil and vegetable samples in two urban streams influenced by effluents disposal from two industries were analysed using PG-990 Model atomic absorption spectrophotometer. Analytical results of water samples in the vicinity of the two industries indicated higher concentrations of Cu, Zn, Pn, Ni and Mn above the acceptable limits reported by the FAO/WHO (2000). The concentration of trace metals in soil and vegetables from the two sites were within the tolerance limits reported by FAO/WHO (2004) and FAO/WHO (2007) respectively. Cd was not detected in water and vegetable samples from NASCO household industrial area and also in water samples from Grand Cereals and Oil Mills area. However, the higher concentrations of trace metals in the polluted (either directly or indirectly) areas were higher than the control indicator that industrial activities such as discharge of wastes and effluents into natural ecosystem in most cases without treatment may cause health hazard as well as environmental pollution.

Keywords: soil, vegetables, effluents, trace metals, pollution, atomic absorptions, spectrophotometer

Introduction

Effluent is an outflow of water or gas to a natural body from a structure such as a sewage treatment plant. Sewage pipe, industrial wastes: water treatment plant or industrial outflow (USEPA, 2006) [19]. Industrial and municipal effluents present a major threat to the aquatic environment and are an important source of environmental pollution (Chamber *et al*., 1997) [7]. Most of these industries discharge their wastes and effluents into natural eco-system in most cases without any treatment thus causing environmental pollution, especially with heavy metals and organic compounds. These hazardous wastes and effluents are generally discharged into a low-lying areas along road sides, streams or in the vicinity of the industrial installations (Chamon *et al*., 2011) [8]. Millions of small-scale farmers in urban and pre-urban areas in developing countries depend on urban streams which are the recipients of the urban effluents or irrigation of crops and vegetables for urban markets. This poses a direct risk (Njuguna *et al*., 2017; Tomno *et al*., 2020; Prabbu, 2009) [18]. The increase in the number of processing and manufacturing plants have also increased the amount of industrial effluents consumption patterns on the other hand and contribute to the accumulation of solid wastes. All these effluents and in some cases solid wastes find their ways into the sewage treatment plants and streams (Kenya Attas, 2007) [12].

Industrial and municipal effluents contain high amounts of heavy metal ions such as chromium, nickel, copper, lead, cadmium and zinc. These heavy-metal-bearing wastewater are a major cause for considerable concern because they are non-degradable, highly toxic and sometimes carcinogenic (Musyoka *et al*., 2013) [13]. Vegetables cultivated on soil polluted with toxic metals due to industrial activities take up heavy metals and accumulate them in their edible and non-editable parts in quantities high enough to cause clinical problems both to animals and human beings consuming these metal rich plants (Gungshik *et al*., 2021; Arora *et al*., 2008; Alam *et al*., 2003) [10, 4, 2]. Therefore, a better understanding of trace metal sources, their accumulation in the soil and the effect of their presence in water, soil and on vegetables samples seem to be particularly important issues of present day research on risk assessment.

Thus the present research works has been undertaken: i) to assess the accumulation status of trace metals in vegetables and ii) to compare the trace metal status of water/soil and vegetables in polluted and non-polluted areas.

Materials and Methods

Sample collection and presentation Water samples

A 100 cm3 acid washed clean plastic containers were used for collection of water samples. A hydro bios water supplier was used to transfer water into 1000 cm3 plastic containers with screw caps. The samples were collected 50m distance between sampling points. The samples were transported to the laboratory and stored in the refrigerator (Wushuang *et al*., 2017) [20].

Soil Samples

A 10 g of soil samples was collected at a depth of 0-5 cm^3 using a clean stainless steel trowel into an acid-washed plastic containers. 3-4 slices of soils were taken from top to bellow to form a representative sample of a whole (Casas *et al*., 2003) [6]. The soil samples were air-dried and then crushed using a porcelain mortar and a pestle, mixed thoroughly and sieved through a 2 mm mesh size. The pondered samples were stored in polyethylene sample bottle prior to analysis (Washuang *et al*., 2017) [20].

Vegetable Samples

About 20 g of the vegetable samples spinach (*Spinacia oleraco*) was collected directly from the farmlands into a polythene bags and sealed. They samples were brought to the laboratory and rinsed with tap water, 0.1 M HCl and distilled water. The samples were sliced and air-derived at room temperature. They were then oven-dried at 1050c to Constant weight. The dried samples were ground and slerved thorough a mesh size of 2 mm and then stored for subsequent ananlysis (Sabu and Kachol, 2006).

Methods

Extraction of trace metals in water samples

To a 50 cm3 aliquot of the water sample 30cm3 of conc HCl and 10cm3 of conc. HNO3 in the ratio of 3:1 (*aqua regia*) was added. The solution was placed on a hot plate and heated at a temperature of 100 cm^3 for 1 hour. After the solution was allowed to cool, it was filtered and then adjusted to 100 cm3 volume with distilled water and stored for determination of trace metals (David and Minate, 2018) [9].

Digestion of soil samples

A 1.0 g of the sieved soil samples was digested with a mixture of 30cm3 conc HCl and 10 cm3 conc. HNO3 in the ratio of 3:1 and heated for 2 hours at 1000c After cooling, the mixture was filtered and made up to 50 cm^3 volume with distilled water and stored for determination of trace elements (Joseph *et al*., 2013) [11].

Preparation of Vegetable Samples

A 2.0g of sieved vegetable sample was placed in proclaim crucible and ashed in muffle furnace at a temperature of 600oC for 6 hours. After cooling, the as hed sample was digested with 15 cm3 of conc HCL and 5 cm3 of HNO3 in the ratio of 3:1. After digestion, the solution was allowed to cool, filtered and made up to 50 cm3 volume with distilled water for the determination of trace metals (David and Minatic 2018) [9].

Determination of trace metals

The concentration of trace metals in water soil and vegetable samples were determined using the atomic absorption spectrophotometer. The filtrates were aspirated into the flame of the PG-990 model atomic absorption spectrophotometer and the absorbance readings were taken. From the calibration curve, the concentrations of the corresponding absorbance were read and deported in mg/l and mg/kg dry weight (Ahmad and Goni, 2009) [1].

Results and Discussion

Trace metal concentrations in water samples

The concentration of trace metals in water samples influenced by effluents from NASCO House Hold Company is presented in Table 1. The higher metal concentration was observed for Fe (3.019±0.04 mg/l, while lead had lower value 0.024±0.00 mg/l. Cadmium was not detected in the samples. The metal concentrations occurred in the sequence, Fe> Zn> Cu> Sn > Mn > Ni> Cr> Pb. The values of Cu (0.520±0.003mg/l), Ni (0.090±0.003 mg/l) and Mn (0.220±0.002 mg/l) were above the recommended values of 0.05 mg/l, 0.02mg/l and 0.10mg/l for Cu, Ni, and Mn. reported by FAO/WHO (2000) respectively. The concentration of trace metals in water sample influenced by effluents from Ground Cereals and Oil Company recorded higher concentration for Fe (4.031±0.04 mg/l) and lower concentration for Co (0.025±0.000mg/l). The concentration of metals occurs in the sequence, Fe> Zn> Cu> Sn> Mn> Ni> Cr> Ph> Co. Cadmium was not detected in the samples (Table 2). The values of Cu (0.494±0.026 mg/l) Ni (0.086±0.003 mg/l) and Mn (0.236±0.005 mg/l) exceeded the recommended values of 0.05 mg/l, 0.002 mg/l and 0.110 mg/l reported by (FAO/WHO 2000) respectively. The concentration of trace metals reported in this work was higher than the values reported by Al-Zarah (2014) [3] but lower than the control sample as shown in Table 3.

Table 1: Trace metal concentration in water, soil and vegetable samples in the vicinity of NASCO household product limited, Jos.

Sample Element	Water	Soil	Vegetables	FAO/WHO (2000) Water	FAO/WHO (2004) Soil	FAO/WHO (2007) Vegetable
Cu	0.520±0.03	0.015±0.012	0.475±0.024	0.05	100	40
Zn	0.835±0.02	1.294±0.04	0.615±0.017	3.00	300	60
Pb	0.024±0.001	0.030±0.011	0.025±0.003	0.05	100	0.3
Ni	0.090±0.003	4670±0.02	0.063±0.004	0.02	50	1.5
Sn	0485±0.02	4.727±0.05	0.203±0.01	50.0	5.0	-
Cr	0.078±0.005	0.116±0.023	0.053±0.004	0.50	1.0	1.5
Fe	3.019±0.04	7.515±0.02	3.520±0.010	10.0	40	50
Co	0.028±0.003	0.082±0.006	0.0260±0.00	0.10	50	0.05-0.10
Mn	0.220±0.001	0.416±0.021	0.123±0.004	0.10	-	5.0

Cd	BDL	0.013±0.000	BDL	0.01	3.0	0.1

Values given as± standard deviation, n = 3; BDL = Below Detection Limit

Trace metal concentrations in soil samples

The concentration of trace metals in soil in the vicinity of NASCO House Hold Company also revealed higher concentration of Fe (7.515±0.020mg/l) and lower concentration of Cd (0.013±0.000mg/l) as presented in Table 1. The metal concentrations occurred in the sequence Fe> Sn> Ni> Zu> Mu> Cr> Co> Pb> Cu> Cd. The concentrations of metals in soil sample were below the recommended values reported by (FAO/WHO 2004). Trace metal concentrations in the vicinity of Grand Cereals and Oil Mills Company recorded higher values for Fe (7.204±0.015 mg/l) and lower values for Cd (0.015±0.000 mg/l). The concentrations of trace metals occurred in the sequences Fe> Ni> Sn> Zn> Cu> Mn> Cr> Co> Pb> Cd (Table 2). The values of trace metal were below the recommended values reported by FAO/WHO (2003). Tomno *et al*. (2020) reported higher concentrations of trace metals in soil in urban stream in municipality in Kenya. The result obtained in the work was higher than control samples as shown in Table 3.

Table 2: Trace metal concentration in water, soil and vegetable samples in the vicinity of grand cereal and oil mills limited, Jos.

Sample Element	Water	Soil	Vegetables	FAO/ WHO (2000) Water	FAO/ WHO (2004) Soil	FAO/ WHO (2007) Vegetable
Cu	0.494±0.026	0.523±0.015	0.511±0.03	0.05	100	40
Zn	0.773±0.012	1.014±0.05	0.574±0.011	3.00	300	60
Pb	0.032±0.002	0.109±0.004	0.040±0.000	0.05	100	0.3
Ni	0.086±0.003	50081±0.200	0.097±0.005	0.02	50	1.5
Sn	0.395±0.016	4.900±0.022	0.255±0.004	50.0	5.0	-
Cr	0.062±0.001	0.075±0.003	0.036±0.000	0.50	1.0	1.5
Fe	4.031±0.014	7.204±0.015	0.335±0.06	10.0	40	50
Co	0.015±0.000	0.064±0.003	0.039±0.000	0.10	50	0.05-0.10
Mn	0.236±0.005	0.443±0.012	0.144±0.002	0.10	-	5.0
Cd	BDL	0.015±0.000	0.010±0.000	0.01	3.0	0.1

Values given as ± standard deviation, n = 3; BDL = Below Detection Lim

Trace metal concentrations in vegetables samples

Trace metals content in vegetables grown in the vicinity of NASCO Household Company revealed higher concentration of Fe (3.520±0.003mg/kg) and lower concentration of Pb (0.025±0.003 mg/kg) as presented in Table 1. The metal concentrations occurred in the sequence, Fe> Cu> Zn> Su> Mn> Ni> Cr> Co> Pb. Cadmium was not detected in vegetables samples. Trace metal concentrations in vegetables grown in the vicinity of Ground Cereal and Oil Mills Company showed higher concentrations of Zn (0.574±0.011 mg/kg) and lower concentration of Cd(0.010±0.000 mg/kg). Metal contents occurred in the sequence, Zn> Cu> Fe> Su> Mn> Ni> Pb> Co> Cr> Cd (Table 2). The concentration of metals in the vicinity of the two industrial areas were within the recommended values reported by (FAO/WHO, 2007) but higher than the control samples. Bigdeli and Seilspour (2008) [5] reported lower concentration of trace metals in vegetables grown in soils irrigated with wastewater.

Table 3: Trace metal concentration in water, soil and vegetable from the control

Sample Element	Water	Soil	Vegetables	FAO/WHO (2000) Water	FAO/WHO (2004) Soil	FAO/WHO (2007) Vegetable
Cu	0.451±0.024	0.541±0.015	0.491±0.023	0.05	100	40
Zn	0.754±0.021	1.096±0.04	0.586±0.02	3.00	300	60
Pb	0.014±0.00	0.101±0.023	0.015±0.000	0.05	100	0.3
Ni	0.066±0.003	4.016±0.011	0.045±0.005	0.02	50	1.5
Sn	0.390±0.020	4.217±0.040	0.181±0.006	50.0	5.0	-
Cr	0.057±0.001	0.081±0.005	0.035±0.000	0.50	1.0	1.5
Fe	2.763±0.030	6.416±0.014	0.315±0.022	10.0	40	50
Co	0.017±0.000	0.065±0.012	0.042±0.011	0.10	50	0.05-0.10
Mn	0.223±0.004	0.386±0.015	0.145±0.02	0.10	-	5.0
Cd	BDL	BDL	BDL	0.01	3.0	0.1

Values given as ± standard deviation, n = 3; BDL = Below Detection Limit

Conclusion

The concentrations of Cu, Ni and Mn in water samples influenced by effluents from the two industries more above the recommended values reported by FAO/WHO (2000). The metals concentrations in vegetables were within FAO/WHO safety limits for human consumption. Although vegetables were accumulating trace metals from soil irrigated with wastewater and effluents, their concentrations did not exceed the recommended values reported by FAO/WHO (2007). But with continuous discharge of wastewater and effluents into streams and farmlands could constitute serious health risk because these metal can bio accumulate in biological systems.

The production and manufacturing companies requires function as domestic and industrial effluent treatment plants designed to engineering standards and operating based on best practices. To reduce the accumulation of heavy metals in soil and vegetables calls for integrated approaches of monitoring, enforcement of compliance standards and public education from key stakeholders, including the

National Environmental Management Authority, Department of Public Health and Department of Country Physical Planning.

References

1. Ahamad JA, Goni MIA. Heavy metal contamination in water, soil and vegetables of the industrial areas in dhaka Bangladesh. Environmental Monitoring Assessment, 2009. Doi 10.1007/1-11
2. Alam MGM, Snow ET, Tanaka A. Arsenic and metal concentration in vegetables grown in Santa village, Bangladesh. The science of Total Environment,2003:308:83-96.
3. Al-Zarah AI. Assessments of trace elements in wastewater effluent in Al-Hassa, Eastern Province of the Kingdom of Saudi Arabia. Research Journal of Environmental Sciences,2014:8(8):405-4421.
4. Arora M, Kiran B, Rani A, Rani S, Kaur B *et al*. Heavy metal accumulation in vegetables irrigated with water from different sources. Food Chemistry,2008:111:811-815.
5. Bigdeli M, Seisepour M. Investigation of metals accumulation in some vegetables irrigated with wastewater in Shahre-Key Iron and toxicological implication, American-Eurasian. Journal Agricultural and Environmental science,2008:4(1):86-92.
6. Casas MI, Rosas H, Soles M, Lac C. “Heavy metals and metalloids in sediments from the Nobergat Basin Span.” Environmental Geology shift,2003:44(3):325-332.
7. Chambers PA, Allard M, Walker SL, Marsalek J, Lawrence J. Impact of municipal wastewater effluents on Canadian waters: A review. Water Quality Journal Canada,1997:32:659-713.
8. Chamon AS, Gerzabek MH, Mondal MN, Ullah SM, Rahnian M, Blum WH. Influence of cereal varieties and site conditions on heavy metal accumulation in cereal crops on polluted soils of Bangladesh.
9. Communications in Soil Science and Plant Analysis,2011:36(7):889-906.
10. David SK, Minati S. Levels and health risk assessment of heavy metals in soil, water and vegetables of Dar- es Salam, Tanzania. Article ID 1402674:9, 2018.
11. Gungshik JR, Salami ST, Gushit JS, Eseyin AE, Ibrahim M. Seasonal variation in trace metal concentrations in soil and vegetables sampels from selected mining areas in Jos South and Barkin Ladi LGA, Plateau State: Journal Chemistry Society of Nigeria,2021:46(6):0963-0971.
12. Joseph CA, Stephen I, Audu ZM, Victor OO. Assessment of heavy metals, pH, organic matter and organic carbon in road sides soils in Te Makindi metropolis Benue State, Nigeria. Journal of Environmental Protection,2013:4:618-628.
13. Kenya Atlas in “Nairobi and its Environment”. A Burgeoning City, 2007, 154-160.
14. Musyoka SM, Ngila JC, Mamba BB. Remediation studies of trace metals in natural and treated water using surface modified biopolymer nanofibres. Physical Chemistry. Earth parts A/B/C,2013:66:45-50.
15. Nager HM, Mahmud NU, Sultana S, Gomes R, Rahman M. Trace metal content in vegetables grown in industrial polluted and unpolluted areas. Bangladesh. Journal of Agricultural Research,2012:37(3):515-527.
16. Njugura SM, Yan X, Cituru RW, Wang QJ. Assessment of macrophyte, heavy metal and nutrient concentrations in water of Nairobi River. Environmental Monitoring Assessment,2017:189:9.
17. Parbu PC. Impact of heavy metal contamination of Akaki River of Ethiopia on Soil and metal toxicity on cultivated vegetables. Electronic Journal of Environmental Agricultural and Food Chemistry,2009:8(9):818- 827.
18. Sahu M, Kacholi DS. “Heavy metal levels in Amaranthus species from Chung Ombo-Michicha and in Temeke District, Dar-es Salam, Tanzania”. Asian Journal of Chemistry,2016:28(5):1125-1126.
19. Tomno RM, Nzewe JK, Mailu SN, Shitanda D, Waswa F. Heavy metal contamination on water, soil and vegetables in urban streams in Machakos, municipality, Kenya. Scientific Africa, 2020, 9(2020). https://doi.org/10:10161/j.sciaf2020e00539.
20. United States Environmental Protection Agency USEPA, 2006. en.m.wikipidia.org. Retrieved on,2010:9:06.
21. Wushuang X, Chi P, Hongloa W, Weipin C. Health risk assessment on trace metals in various environmental media, crops and human hair from a mining affected area. International Research and Public Health,2017:14(12):1595.