Journal of Academia and Industrial Research (JAIR)
Volume 3, Issue 5 October 2014

ISSN: 2278-5213

RESEARCH ARTICLE

Commelina benghalensis and *Ipomoea pes-caprae* as Indicators of Heavy Metal Contamination along Mobil Terminal Operational Base, Niger Delta, Nigeria

U.U. Umoh[1*], S.F. Dan[1,2] and Okon E.E. Duke[1]
[1]Dept. of Pure and Applied Chemistry, University of Calabar, Cross River State, Nigeria
[2]Dept. of Marine Chemistry, Faculty of Ocean Science and Technology, Akwa Ibom State University, Akwa Ibom State, Nigeria
unyimeumoh85@yahoo.com*, +2348022201049

Abstract

Heavy metals are known to pose potential threats to terrestrial and aquatic lives. However, little is known on the toxic levels of heavy metals found in *Commelina benghalensis* and *Ipomoea pes-caprae* that are used in traditional medicine in Nigeria. To understand the extent of heavy metal accumulation and their potential toxicity, we investigated the bioconcentration factor (BCF), seasonal variation and distribution of heavy metals in roots, stems and leaves of *C. benghalensis* and *I. pes-caprae* collected along mobil oil terminal operation base, South Eastern Niger Delta, Nigeria. Concentrations of Zn, Pb, Cu and Cd in the present study were found to be relatively high in roots, stems and leaves of *I. pes-caprae* and *C. benghalensis* when compared to other studies. Cu had the highest BCF in *C. benghalensis* during dry season (21.44) followed by Pb in *I. pes-caprae* (20.74). In wet season, Pb exhibited the highest BCF value of 10.88 in *C. benghalensis* followed by Cu (7.44) in both *C. benghalensis* and *I. pescaprae*. Cr was absent during wet season. This seasonal variation may be due to greater wash-in of metals from petroleum production activities during wet season. From this study, *I. pes-caprae* and *C. benghalensis* have been classified as excellent bioindicators for Cu, Pb and Cd.

Keywords: Heavy metals, *C. benghalensis, I. pes-caprae,* bioindicator, bioconcentration factor, Niger Delta.

Introduction

The rapid industrialization in coastal communities has triggered concern on the contamination of our coastal resources by heavy metals. There is no gain saying that anthropogenic factors have generally dampened natural ecosystem. Wars, mining activities, oil exploitation and fertilization of farmland to name but few are posing a serious threat to our marine environment. The concentration of heavy metals in the environment tends to increase due to these human activities. Heavy metals are trace elements with the density of ≥3 g/cm^3, which on the low concentration was required by organism, but toxic in the higher concentration for physiological organism (Banvalvi, 2011). One of the water pollution problem in Indonesia was heavy metals, particularly Lead (Pb), Cadmium (Cd), Chromium (Cr) and Copper (Cu) that often exceeded the water quality standard for drinking water, agriculture and/or fisheries (Soeprobowati *et al.,* 2001; Soeprobowati and Hariyati, 2012). Many studies have determined the toxic levels of heavy metals for certain plants, especially those metals considered as public health threats (Reeves and Baker, 2000; Terry and Banuelos, 2000; Sudharsan *et al.*, 2012). At low concentrations, some of the heavy metals excite some biological processes, but at threshold concentration these become toxic. Being non-biodegradable metals accumulate at various trophic levels through food chain and can cause human health problems (He *et al.,* 1998).

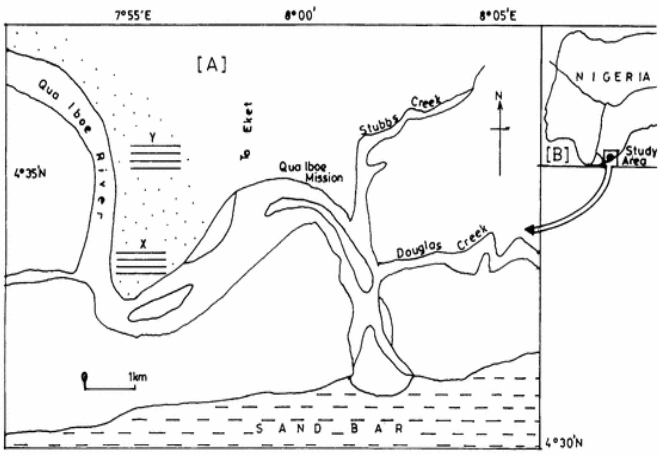
In humans, these metals hoard in living tissues and thus multiply the danger. Some metals cause physical distress while others may cause life-threatening illness, damage to vital body system or cause other damages. Thus, it is very essential to control emission of heavy metals into the environment. Organisms which accumulate contaminants in their tissues (biomonitors) can be used to assess the health of coastal environments, including presence, levels and changes of contaminants. Keeping the above facts in view, this study evaluated *Ipomoea pes-caprae* and *Commelina benghalensis* as indicator of heavy metal accumulation during wet and dry seasons along the study area.

Materials and methods

Study area: Ibeno coastline (Fig. 1) is a sandy beach located in Akwa Ibom State that attracts thousands of tourists worldwide annually. The major river in the study area is Qua Iboe River which empties into the Atlantic Ocean (Umoh *et al.,* 2014). The study area is in a tropically humid climatic region characterized by distinct dry and wet seasons. The wet season, which sometimes begins in March or April to October, is always characterized by heavy storms of short duration. The dry season which normally lasts 3-5 months is comparatively short beginning in November and extending to February. The mean annual rainfall ranges from 2,000 to 3,200 mm for the study area.

The mean annual temperature in the study area is fairly constant and averages about 28°C. Relative humidity is comparatively uniform over the area with mean value of 80% for October and 60% for dry season. It varies depending on the heaviness of the rains (Udosen *et al*., 2012). The main activities of the people are boat construction, fishing and sand mining with offshore oil drilling activities by Mobil-Exxon Nigeria unlimited (Uwah *et al.,* 2013).

Fig. 1. Map of the study area.



Plant collection: All plants were collected from two locations along the Mobil terminal operation base, South eastern Niger Delta, Nigeria. Samples of *Ipomoea pes-caprae* and *Commelina benghalensis* were generally found growing over sandy substrates near the intertidal offshore. Collected whole plants (50-100 g, fresh weight) were placed in polyethylene bags rinsed with doubled distilled water to eliminate salts and foreign particles. All samples were preserved in a cooler immediately after sampling at temperature of 4°C and were transported to the laboratory prior to further treatments and analysis.

Sample treatment and preparation: Prior to treatment, samples were identified in the Dept. of Botany, University of Calabar. Tissues samples for iron analysis were obtained from the leaves, stem and roots of the species, since these parts are essentials to analysis. Samples were dried overnight in an oven at a constant temperature of 60°C. Dried samples were ground and stored in plastics bags prior to digestion process.

Sample digestion: About 2 g of dried samples were poured into digestion flask and 20 mL conc. H_2SO_4, 10 mL conc. HNO_3, 16 g Na_2SO_3 and anti-bombing granules were added and mixed. The mixture was heated until a clear solution was observed. The beaker was then removed from the hot plate, cooled and transferred into 100 mL volumetric flask. The content of the flask was then diluted and made up to the mark with distilled water. This was then stored in sample bottles until required.

Heavy metal analysis: For the determination of heavy metals, 10 mL aliquot from the stock samples was taken and volume was adjusted to 100 cm^3 with distilled water. The treated samples were taken for the analysis of Cd, Cu, Co, Cr, Ni, Pb and Zn using atomic absorption spectroscopy.

Statistical analysis: Statistical analysis was done using SPSS 13 for calculating mean and standard deviation.

Results and discussion

Root, stem and leaf samples of two species, *Ipomoea pes-caprae* and *Commelina benghalensis* were studied for the determination of levels of six metals viz. Cd, Cr, Cu, Ni, Pb and Zn during wet and dry season. These samples were collected from two locations along the Mobil terminal operation base, South-Eastern Niger Delta, Nigeria. The data presented in Table 1 shows the descriptive stat and mean bioconcentration factor (BCF) of heavy metals in plant tissues. The concentration of metals were found to vary in leaf of *I. pes-caprae* from 0.003 mg/g for Ni, 0.05 mg/g for Cu, 1.18 mg/g for Zn and 1.58 mg/g for Pb while Cr and Cd were below detection limit during dry season giving the decreasing order of metals levels to be Pb>Zn>Cu>Ni>Cr>Cd. Cu, Cr and Ni were below detection limit in stem of *I. pes-caprae* during dry season while Zn showed highest concentration of 2.58 mg/g followed by Pb (1 mg/g). The trend of metal concentration in root of *I. pes-caprae* ranged from 0.075 mg/g for Ni, 0.3 mg/g for Cd, 0.35 mg/g for Cu, 1.78 mg/g for Pb and 3.38 mg/g for Zn during dry season. Generally, the mean concentration of metal in *I. pes-caprae* during dry season ranged as Ni (0.05±0.04), Cu (0.2±0.21), Cd (0.39±0.12), Pb (1.45±0.40) and Zn (2.38±1.11). Qari and Siddique (2009) reported similar high concentration of Zn in seaweed (Rhodophyceae) along Karachi Coast, India.

In *Commelina benghalensis* Cr, Ni and Pb were below detection limit in root during dry season. Zn was found to have the highest concentration while Cd showed a remarkable concentration in root of the same species (Table 1). Zn was also found with high concentration in stem (6.03 mg/g) whereas, Cu showed the highest value in leaf of the same species during dry season. Wet season concentration of metal varied from 0.05 mg/g for Cd, 0.18 mg/g for Ni, 0.4 mg/g for Pb, 0.88 mg/g for Cu and 3.43 mg/g for Zn in *I. pes-caprae* leaf, Cr was absent in wet season of the present study. Cd and Ni were found with the minimum concentration in stem tissue of *I. pes-caprae* (0.93 mg/g) during wet season followed by Cu (0.43 mg/g), Pb (0.68 mg/g) and Zn (4.3 mg/g) (Table 2). Similar concentration was observed in root tissue of the same species. Zn dominated the concentration of metals in *C. benghalensis* during wet season with Cd absent in root tissue. Generally, Zn concentration overwhelmed other metals in different tissues of the present study.

Table 1. Concentration of heavy metals in leaf, stem and root of plants during dry season.

Samples	Metals	Conc. (mg/g)	Mean	Std. deviation	BCF
I. pes-caprae leaf		0.05			
I. pes-caprae stem	Cu	ND	0.20	0.21	2.22
I. pes-caprae root		0.35			
I. pes-caprae leaf		ND			
I. pes-caprae stem	Cd	0.48	0.39	0.12	4.88
I. pes-caprae root		0.3			
I. pes-caprae leaf		ND			
I. pes-caprae stem	Cr	ND	NA	NA	NA
I. pes-caprae root		ND			
I. pes-caprae leaf		0.03			
I. pes-caprae stem	Ni	ND	0.05	0.04	0.004
I. pes-caprae root		0.08			
I. pes-caprae leaf		1.58			
I. pes-caprae stem	Pb	1	1.45	0.40	20.74
I. pes-caprae root		1.78			
I. pes-caprae leaf		1.18			
I. pes-caprae stem	Zn	2.58	2.38	1.11	0.37
I. pes-caprae root		3.38			
C. benghalensis leaf		2.9			
C. benghalensis stem	Cu	1.78	1.93	0.90	21.44
C. benghalensis root		1.13			
C. benghalensis leaf		1			
C. benghalensis stem	Cd	0.38	1.35	1.19	16.88
C. benghalensis root		2.68			
C. benghalensis leaf		1.3			
C. benghalensis stem	Cr	0.13	0.71	0.83	7.1
C. benghalensis root		ND			
C. benghalensis leaf		0.15			
C. benghalensis stem	Ni	0.4	0.28	0.18	0.022
C. benghalensis root		ND			
C. benghalensis leaf		0.95			
C. benghalensis stem	Pb	0.88	0.91	0.05	11.375
C. benghalensis root		ND			
C. benghalensis leaf		1.98			
C. benghalensis stem	Zn	6.03	4.48	2.19	1.676
C. benghalensis root		5.45			

NA=Not applicable, ND=Not detected.

Cr was only present in leaf and stem tissues during dry season of the present study unlike dry season. Metal availability was observed more during wet season and this may be associated with high input of metals from inland drainage, atmospheric source through rainfall, municipal waste input, industrial activities and mainly the oil drilling activities of the study area. Bioconcentration factor (BCF) is the concentration of a particular chemical in a biological tissue per concentration of that chemical in the surrounding environment (e.g. water or sediment). The BCF value of the present study was calculated using Uwah *et al*. (2013), sediment data and the result was recorded in Table 1. The result showed that Pb with the highest BCF value of 20.74 during dry season indicating *I. pes-caprae* as a good bioindicator of Pb. However, *C. benghalensis* is a bioindicator of Cu, Cd, Pb and Cr with BCF value of 21.44, 16.88, 11.38 and 7.1 respectively during dry season.

BCF values were <1 during wet season exception of Cu and Pb in both species (*Ipomoea pes-caprae*: Cu = 7.4, Pb = 6.4 and *Commelina benghalensis:* Cu = 7.4, Pb = 10.88) (Table 2).

Conclusion

The study revealed that *Ipomoea pes-caprae* and *Commelina benghalensis* appear to have the potentials to be excellent bioindicators of Zn, Pb, Cu and Cd with higher preference to Pb, Cu and Cd. This high potential in both species is more prominent in stem and leaf than in root. Implication here is that the study area is chemically contaminated with the four metals probably as a result of industrial discharge associated with petroleum production and other industrial activity within the region. There was mark variation in the distribution of the metals in both species of the present study with season. Higher levels recorded for the wet season may be associated with greater wash in.

Table 2. Concentration of heavy metals in leaf, stem and root of plants during wet season.

Samples	Metals	Conc. (mg/g)	Mean	Std. deviation	BCF
I. pes-caprae leaf	Cu	0.88	0.67	0.23	7.44
I. pes-caprae stem		0.43			
I. pes-caprae root		0.7			
I. pes-caprae leaf	Cd	0.05	0.03	0.01	0.38
I. pes-caprae stem		0.03			
I. pes-caprae root		0.03			
I. pes-caprae leaf	Cr	ND	NA	NA	NA
I. pes-caprae stem		ND			
I. pes-caprae root		ND			
I. pes-caprae leaf	Ni	0.18	0.08	0.08	0.01
I. pes-caprae stem		0.03			
I. pes-caprae root		0.05			
I. pes-caprae leaf	Pb	0.4	0.51	0.15	6.38
I. pes-caprae stem		0.68			
I. pes-caprae root		0.45			
I. pes-caprae leaf	Zn	3.43	3.64	0.58	0.57
I. pes-caprae stem		4.3			
I. pes-caprae root		3.2			
C. benghalensis leaf	Cu	0.75	0.67	0.41	7.44
C. benghalensis stem		0.23			
C. benghalensis root		1.03			
C. benghalensis leaf	Cd	0.05	0.04	0.02	0.5
C. benghalensis stem		0.03			
C. benghalensis root		ND			
C. benghalensis leaf	Cr	ND	NA	NA	NA
C. benghalensis stem		ND			
C. benghalensis root		ND			
C. benghalensis leaf	Ni	0.03	0.05	0.04	0.004
C. benghalensis stem		0.03			
C. benghalensis root		0.1			
C. benghalensis leaf	Pb	0.38	0.87	0.46	10.88
C. benghalensis stem		0.95			
C. benghalensis root		1.28			
C. benghalensis leaf	Zn	3.53	3.87	0.31	0.60
C. benghalensis stem		3.95			
C. benghalensis root		4.13			

NA=Not applicable, ND=Not detected.

Acknowledgements

We acknowledge the overwhelming financial support of Mrs. Nsa Akpan Edem, the mother of the corresponding author.

References

1. Al-Homaidan, A. 2007. Heavy metal concentration in three species of green algae from the Saudi coast of the Persian Gulf. *J. Food Agri. Environ.* 5(3-4): 345-358.
2. Banvalvi, G. 2011. Cellular effects of heavy metals. Springer. London, http://dx.doi.org/10.1007/978-94-007-0428-2. p.364.
3. Besada, V., Andrade, J.M., Schultze, F. and Gonzalez, J. 2009. Heavy metals in edible seaweeds commercialized for human consumption. *J. Marine Syst*. 75: 305-313.
4. He, M., Wang, Z. and Tang, H. 1998. The chemical, toxicological and ecological studies in assessing the heavy metal pollution in Le An River, China. *Water Res*. 32(2): 510-518.
5. Qari, R. and Siddiqui, S.A. 2009. A comparative study of heavy metal concentrations in red seaweeds from different coastal areas of Karachi, Arabian Sea. *Ind. J. Marine Sci*. 39(1): 27-42.
6. Reeves, R. and Baker, A.J.M. 2000. Metal-accumulating plants. Phytoremediation of toxic metals: Using plants to clean up the environment. John Wiley, pp.193–229.
7. Soeprobowati, T.R. and Hariyati, R. 2012. The potential use of microalgae for heavy metals remediation. Proc. of 2nd Int. Seminar on New Paradigm and Innovation on Natural Science and its Application, Diponegoro University, Semarang Indonesia, 3 October 2012, pp.72-87.
8. Soeprobowati, T.R., Sugondo, H., Hendrarto, I.B., Sumantri, I. and Toha B. 2001. Diatom and ecological changes of the River. *Seri Penelitian Fakultas Biologi.* 4(2): 72-97.
9. Sudharsan, S., Seedevi, P., Ramasamy, P., Subhapradha, N., Vairamani, S. and Shanmugam, A. 2012. Heavy metal accumulation in seaweeds and sea grasses along southeast coast of India. *J. Chem. Pharmaceut. Res.* 4(9): 4240-4244.
10. Terry, N. and Banuelos, G. 2000. Phytoremediation of contaminated soil and water. *Lewis Publishers, Inc.*
11. Udosen, E.D., Ukpong, M.E. and Etim, E.E. 2012.Concentrations of heavy metals in soil samples with in Mkpanak in Ibeno Coastal Area of Akwa Ibom State. *Niger. Int. J. Modern Chem.* 3(2): 74-81.
12. Umoh, U.U., Dan, S.F. and Etim, I.N. 2014. Mineral iron content of *Commelina beghalensis, Paspalum vaginatum, Ipomoea pes-caprae* and *Philoxerus vermiculeris* found along Ibeno Coastline, Nigeria. J. Acad Indus. Res. 3(4): 198-201.
13. Uwah, I.E., Dan, S.F., Etiuma, R.A. and Umoh, U.U. 2013. Evaluation of status of heavy metals pollution of sediments in Qua-Iboe River estuary and associated creeks, South-Eastern Nigeria. *Environ. Pollut.* 2: 4.
14. Vymazal, J. 1995. Algae and element cycling in wetlands, C.R.C Press, Boca Raton, USA.