Original Research Article

Seasonal Variation of Heavy Metals Concentration of Industrial Effluents and Receiving Rivers in Iguosa and Ikopba, Benin City, Edo State.

ABSTRACT

This study was carried out to investigate the impact of pollution on the receiving waters (Iguosa and Ikopba rivers) in Benin City. Effluents and water samples were analysed quantitatively for the presence of lead (Pb), Copper (Cu), Chromium (Cr), Manganese (Mn), Iron (Fe), Zinc (Zn) and Nickel (Ni) for both wet and dry season were determined using Atomic Absorption Spectrometer (AAS). Heavy metals analysis results for 7-Up Bottling Company showed that Pb (0.06mg/L – 0.97mg/L), Cu (0.12mg/L – 2.84mg/L), Cr (0.5mg/L – 8.16mg/L), Mn (0.88mg/L – 4.36mg/L), Fe (0.55mg/L – 7.55mg/L), Zn (0.38mg/L – 3.97mg/L), Ni (0.27mg/L – 1.66mg/L) and Cd (0.03mg/L – 0.74mg/L) while results for Guinness Nigeria Plc showed that Pb (0.06mg/L – 0.95mg/L), Cu (0.07mg/L – 2.62mg/L), Cr (0.14mg/L – 2.96mg/L), Mn (0.16mg/L – 6.63mg/L), Fe (0.31mg/L – 4.96mg/L), Zn (0.14mg/L – 7.98mg/L), Ni (0.12mg/L – 1.69mg/L) and Cd (0.03mg/L – 0.56mg/L) for both wet and dry season. This showed that the concentrations of the metals were higher during wet season than the dry season except that of lead and cadmium. However, the presence of metals at various concentrations revealed that the effluents from these industries contaminated the stream.

Keywords: Atomic Absorption Spectrometer (AAS); Heavy metals; Concentrations; toxic; Effluents.

1.0 INTRODUCTION

Water pollution may be defined in various ways. However, [1], while explaining water pollution described it as a situation in which water in its pure state undergoes natural or induced change in its quality which renders it unusable or dangerous as regards food, human and health, industry, agriculture, fishing or leisure pursuit. All these are induced by human activities. The main cause of water pollution is the discharge of solid waste or liquid waste product containing pollutants on to the land surface or coastal water. [2, 3] in separate studies have reported the contamination of either ground or surface water in Nigeria by industrial effluents.

The largest volume of discharged waste is in form of effluent. This is a broad term that may be used to describe any solid, liquid or gaseous waste in a treat or untreated condition that is discharged from a process. In relation to water pollution, effluent is usually liquid and gases that vary considerable in composition [4]. Most industries discharge their untreated effluents through drains or canals into the nearest water body like streams, rivers and seas, relying on dispersal by dilution, thereby causing water pollution problems [5]. The effluents contain solid inorganic matter, organic matter, toxic substances, mineral nutrients, oils, suspended solids, dissolved solids, acid and alkalis. Some industries effluents which though devoid of toxic substances but dangerous to aquatic life [5].

Water-born wastes present a potential hazard to water system. Theses waste can contain organic matter that causes de-oxygenation by promoting microbial activity or material which is directly toxic to the various life forms in the system. Industrial wastes and emission contain toxic and hazardous substance most of which can be detrimental to human health [6]. These include heavy metal such as lead, cadmium, mercury, nickel, zinc, manganese and toxic chemicals such as pesticides, polychlorinated bisphenol (PCBs), dioxins, polyaromatic hydrocarbon (PAHs), petrochemicals and phenolic compound [7]. The heavy metals may be present in varying concentration depending on the volume of effluents and the concentration of those metals in the effluents discharged into the receiving water [8].

As far as receiving waters are concerned, three types of adverse effects are recognized. These are nutritional pollution which can be either organic or inorganic, chemical pollution which includes direct toxicity, acidity, alkalinity and salinity alteration; and physical pollution such as changes in temperature, turbidity and surface properties of water [4]. Many of the receiving water channels do not possess adequate assimilative capacity for the effluent hence; coloured, moldy, unwholesome surface water, fish kills and loss of recreational amenities are encountered. Some of the polluted streams and rivers emit odours and/or contain floating oil. These conditions are aesthetically unsightly making the water bodies unattractive for human recreation. A significant proportion of the population along the channels obtains their drinking water and household water from these unwholesome sources. Industries also need water of acceptable quality for its process [4].

2.0 MATERIALS AND METHODS

Sample collection, preservation and analysis. The effluents and receiving water samples (upstream and downstream) were collected respectively using clean plastic bottles. About 5mls of concentrated hydrochloric acid was added to 250ml of each water sample and evaporated to 25ml. the concentrate was filtered using cellulose membrane (0.45um) and transferred to a 50ml flask and diluted to mark with de-ionised water. The heavy metals were then determined quantitatively using Atomic Absorption Spectrometer (ASS) [9, 10]. The data were presented as mean ± standard deviation of the replicated samples.

3.0 RESULTS AND DISCUSSION

A comparison of table 1 and 2 and fig 3 and 4 showed the heavy metal contents of effluents and receiving water for both industries. The lead contents of 7-Up (0.11mg/L – 0.97mg/L) and GNP (0.06mg/L – 0.95mg/L) were in close range and complied with [11] recommended value of (<1.0mg/L) copper content of the water samples from GNP at dry season was significantly lower than that of samples from 7-Up. However, the values obtained was a bit higher than the recommended (0.1mg/L) [11] but within the range specified by [12]. It was also observed that the values obtained for all the receiving water samples were significantly lower than the effluents. This may be due to dilution effect of the receiving waters. The concentrations range of all water samples i.e. (0.07mg/L – 1.0mg/L) except that of lead (Pb) and manganese (Mn) were within the range of values reported by [13] and higher compared to value recorded by [14].also, the concentration obtained with respect to Pb, Cd, Zn and Ni were within the standard (1.00mg/L) recommended by [15].

It was also observed during the zinc concentration of the effluents from 7-Up was the highest of all the metals determined at the season. This was closely followed by chromium. However, toxicity identification studies have indicated that accumulation of zinc for instance may be the primary cause of toxicity in certain contaminated aquatic systems..

Table 1: Heavy Metal Contents of Effluents and Receiving Water samples from Iguosa and Ikpoba Rivers, Benin City. (Dry and Wet)

	Pb	Cu	Cr	Mn	Fe	Zn	Ni
7-UP							
Dry Season							
Effluent	0.97±0.01	0.38±0.01	0.50±0.02	1.14±0.01	0.92±0.02	0.92±0.02	0.90±0.01
Upstream	0.66±0.01	1.09±0.01	0.52±0.01	0.88±0.01	0.55±0.01	0. 38±0.01	0.27±0.01
Downstream	0.54±0.01	0.20±0.01	0.58±0.02	0.96±0.01	0.64±0.01	0.50±0.02	0.32±0.02
Wet Season							
Effluent	0.28±0.01	2.84±0.15	8.16±0.02	1.49±0.15	7.55±0.02	8.57±0.02	1.66±0.02
Upstream	0.06±0.01	0.93±0.01	1.97±0.01	2.34±0.02	1.89±0.15	2.65±0.02	1.06±0.01
Downstream	0.11±0.00	1.13±0.12	2.49±0.02	4.36±0.25	2.13±0.02	2.97±0.02	1.29±0.02
GNP							
Dry Season							
Effluent	0.95±0.02	0.17±0.02	0.40±0.01	0.86±0.01	0.64±0.01	0.57±0.02	0.65±0.02
Upstream	0.34±0.02	0.07±0.01	0.14±0.02	0.61±0.02	0.31±0.02	0.14±0.01	0.12±0.02
Downstream	0.81±0.01	0.12±0.01	0.43±0.01	0.16±0.02	0.36±0.01	0.42±0.02	0.32±0.02
Wet Season							
Effluent	0.75±0.02	2.62±0.02	2.96±0.02	6.63±0.01	4.96±0.01	7.98±0.02	1.69±0.02
Upstream	0.06±0.02	0.45±0.01	2.20±0.02	4.43±0.02	1.25±0.02	1.44±0.01	0.65±0.02
Downstream	0.10±0.01	0.56±0.01	2.48±0.01	4.76±0.02	1.48±0.01	1.51±0.02	0.75±0.02

Keys: 7-Up – Seven Up Bottling Company Ltd, GNP – Guinness Nigeria Plc

Higher concentration of zinc is especially toxic to aquatic insect (Ranatra elongata). The high concentration suggested that some of the raw materials used by these industries may be rich in these metals. It was also observed that the concentrations of the metals were surprisingly lower in receiving waters than the effluents discharged into them. This may be partly due to dilution effect of the receiving waters

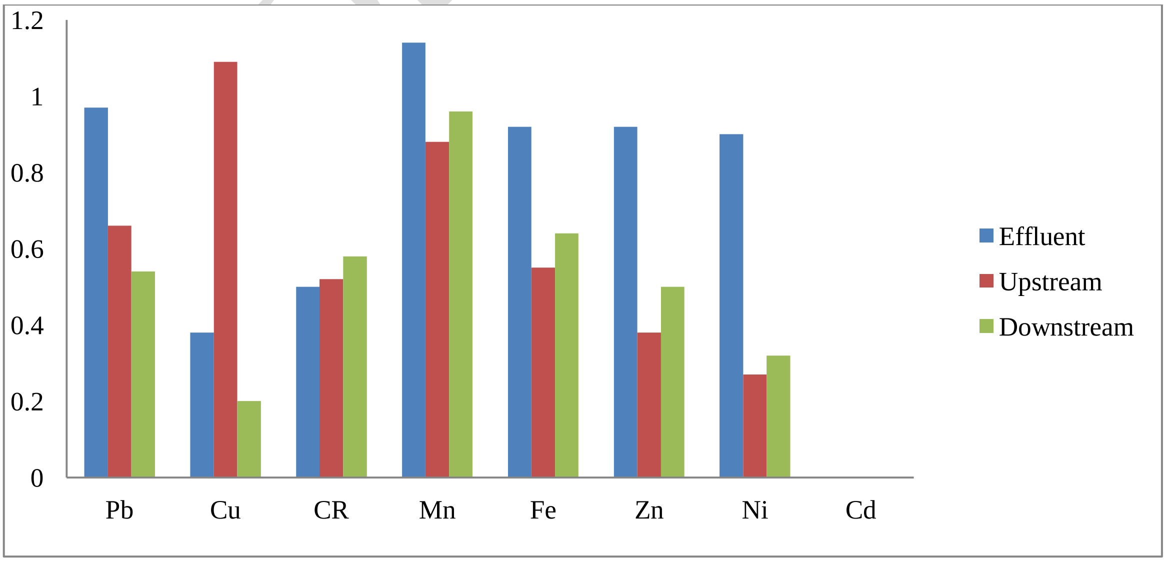

Fig. 1: Heavy Metal Contents of Effluent and Receiving Water from Seven-Up Bottling Company (Dry Season)

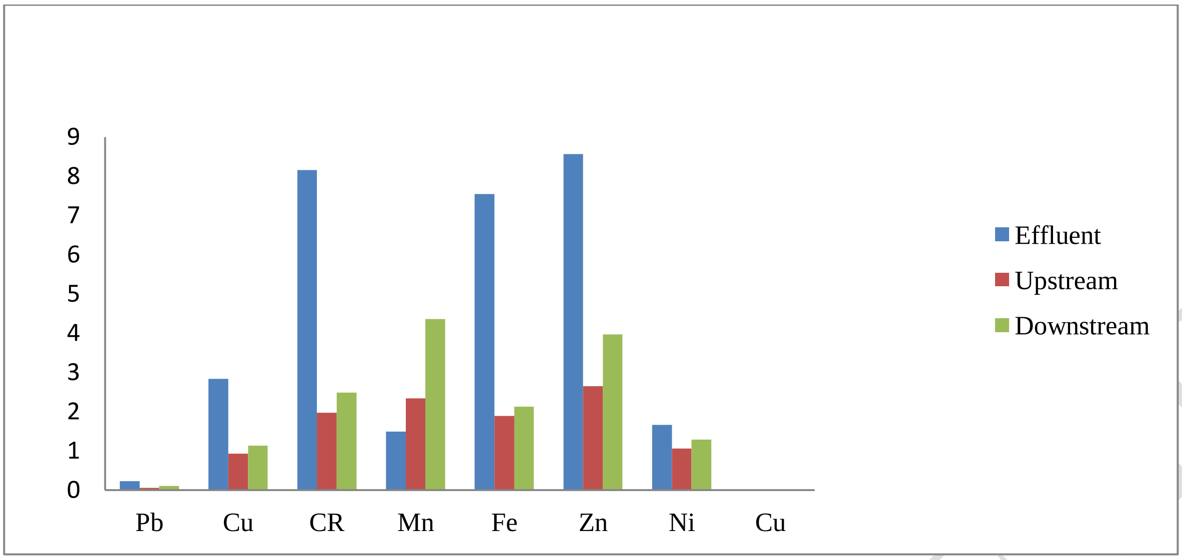

Fig. 2: Heavy Metal Contents of Effluent and Receiving Water from Seven-Up Bottling Company (Wet Season)

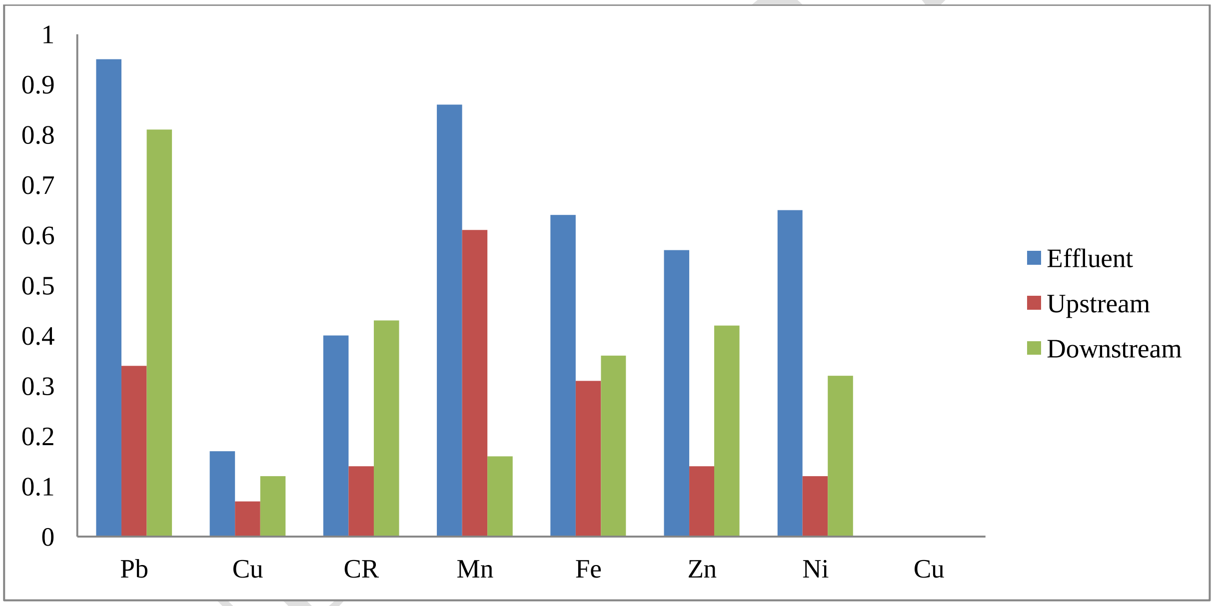

Fig.3: Heavy Metal Contents of Effluent and Receiving Water from Guinness Nigeria Plc. (Dry Season)

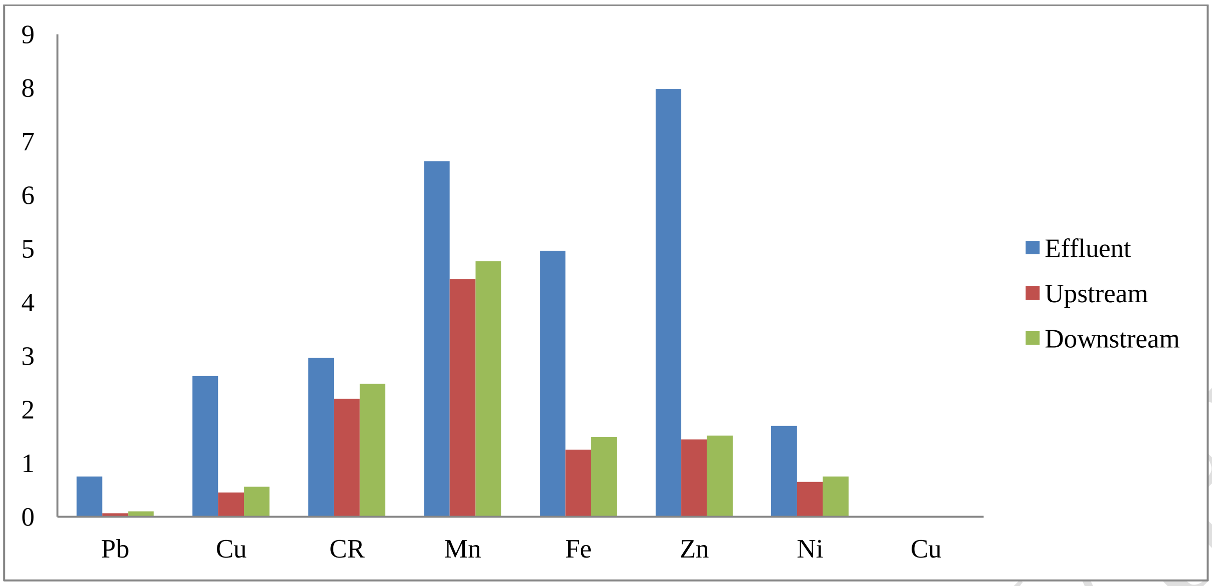

Fig. 4: Heavy Metal Contents of Effluent and Receiving Water from Guinness Nigeria Plc. (Wet Season)

It is noteworthy that the cadmium content in water samples from the two industries was the lowest of all the metals determined and was within the range of 1.0mg/L and 0.5mg/L recommended by [15]. The concentrations of iron obtained at this season (0.31mg/L – 7.55mg/L) were also blow permissible limit of (20mg/L) recommended by [15]. Also, the concentration obtained for effluents with respect to Cd, Ni, Cr, and Zn were above the range (0.03mg/L – 1.0mg/L, 2.0mg/L and 5.0mg/L respectively) recommended by [15]. With the exception of lead and cadmium concentrations, these was higher concentration in wet season than dry season. However, the presence of heavy metals at various concentrations revealed that the effluents from these industries had contaminated the streams.

CONCLUSION

The results of the Heavy metal analysis on Industrial effluents and the receiving water for both wet and dry seasons in this study showed that the values obtained were somehow higher than the permissible limits recommended by World Health Organization. This clearly suggested that these effluents from both Industries have seriously polluted the receiving water bodies .However, if Industrial activities are not properly controlled or regulated and modified, it might lead to serious environmental pollution and degradation of Ikpoba-Oha and Oluku Rivers in Benin City in the nearest future.

REFERENCES

[1] K. O. Ipinmoroti, I. A. Amoo, S. A. Adebisi, 2007. Effluent and receiving water quality near food processing industries in Ibadan metropolis. *Journal of Food Technology* 5(1), 23-25.

[2] K. O. Ipinmoroti, O. Olaofe, C. E. Adeeyinwo, 1997. Interrelationship of heavy metals concentrations in water, sediments and fish samples from Ondo coastal area. *African Journal of Science* 1(1), 55-61.

[3] Asuquo, 1998. Physico-chemical characteristics and anthropogenic pollution of the surface waters of Calabar rivers, Nigeria. *Global Journal of pure and applied Sciences* 5(4), 595-600

[4] K. Ogendengbe, C. O. Akinbile, 2010. Comparative analysis of the impact of industrial and agricultural effluent on Ona stream in Ibadan, Nigeria. *New York Science Journal,* 3, 7.

[5] A. R. Ipeaiyeda, , P. C. Onianwa 2009. Impact of brewery effluent on water quality of Olosun in Ibadan, Nigeria. *Chemistry and Ecology* 25, 189-204.

[6] A. T. Etchie, T. O. Etchie, G. O. Adewuyi, 2012. Systematic chronic health risk assessment of residential exposure to Cd^{2+} and Cr^{6+} in ground water. *Toxicological and Environmental Chemistry* 94, 181-194.

[7] O. S. Amuda, E. T. Ayoade, O. A. Owoade, A. Adetutu, 2001. Hydrocarbon accumulation and discharge by crayfish in some rivers of Lagos, Nigeria. *Bulletin Chemical Society of Ethiopia* 15(2), 167-172.

[8] G. Mebrahtu, S. Zerabuk, 2011. Concentration of heavy metals in drinking water from urban areas of the Tigray region, North Ethiopia. *Momona Ethopia Journal of Science* 3, 105-121.

[9] C. M. A. Ademoroti, 1996. Standard methods for water analysis. 1st Edition, *Foludet Press Limited, Ibadan, Nigeria.* pp. 218. 2000.

[10] B. A. Adelekan, K. D. Abegunde, 2011. Heavy metals contribution of soil and ground water at automobile mechanic villagas in Ibadan. *International Journal of Physical Science* 6(5), 1045-1058.

[11] WHO. World Health Organization, 2017. Guidelines for drinking water quality: fourth edition incorporating the first addendum. *WHO Library Cataloguing-in-Publication Data*

[12] D. T. Tang, R. J Ferris,. 2000. Effluent Standards. Environmental Protection Administration of the Republic of China on Taiwan. P11

[13] G. H. Udom, J. O. Etu-Efeotor, E. O. Esu, 1997. Hydrochemical evaluation of ground water in parts of Port-Harcourt and Tai-Eleme local government area in Rivers State, Nigeria. *Global journal of Pure and Applied Sciences*, 5, 545 – 552.

[14] R. Dande, A. S. Bayero, I. B. Koki, 2019. Determination of heavy metal in an industrial wastewater, using Atomic Absorption Spectrophotometer. *Proceedings. of the 4th YUMSCIC July, 2019,* 4, 539-542.

[15] Federal Environmental Protection Agency, FEPA. 2003. *Guidelines and Standard for Environmental Pollution Control in Nigeria. P* 238 .