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Concentration of Fe, Cu, Cr, Zn and Pb in Makera – Drain, Kaduna, Nigeria

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ABSTRACT

The concentration of Fe, Cu, Cr, Zn, Cd and Pb in effluent from Makera drain in Kaduna was determined seasonally by the use of Atomic Absorption Spectrophotometer (AAS). The monthly levels of the metal concentrations and the mean metal concentration of the four sampled stations showed that Fe>C>Cu>P>Zn>Cd in decreasing order of magnitude. The concentration of some of these metals determined were higher than the recommended World Health Organization (WHO) levels of 0.1mg/l, 0.05 mg/l , 0.01 and 0.1mg/1 for Fe, Cu, Cd and Pb respectively, for drinking water. There were high significant variation ($P<0.01$) between stations, months and seasons, except for Zn, which had significant variation ($P<0.05$) between months and insignificant variation ($p>0.05$) between seasons. This study highlights the implication of the high concentration of these metals on the biota and consequently man who is at the end of the food chain.

Key words: Makera drain, heavy metals.
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INTRODUCTION

Due to rapid population growth, urbanization, industrialization, and exploitation of natural resources, there has been a steady increase in the quantity, quality and diversity of discharges into the aquatic environment [1]. These discharges contain huge amount of heavy metals which adversely affect the physicochemical properties of the receiving water and consequently its biota. Industrial waste discharge into the coastal area of the United Kingdom which contained toxic heavy metals claimed several aquatic lives [2]. The adverse consequences of consuming water and food containing high level of chromium VI, include lung tumors and skin irritation, [3]. Pollution and contamination of the aquatic environment in Nigeria is increasing in scope and magnitude. This could be attributed to the development of various types of industries, increase in the population of the people, especially in urban centres and the inadequate consideration to environmental impact analysis of the various developmental projects [4].

Nigeria generates over 500, 000 tons of waste annually [5], River Kaduna receives over 500, 000 m^3 /day of untreated effluent from various industries in Kaduna through 53 tributaries and Makera Drain is one of such. Makera drain receives waste from domestic and industrial sources such as food and beverages, oil depot, numerous textiles companies such as Kaduna Textiles Limited (KTL), Zamfara Textiles Limited (ZTL), United Nigerian Textiles Limited (UNTL), Norspin, Nigerian Brewery Ltd (NBL) and Changchangi Oil Depot.

Available record showed that about 216,700 m^3/day of wastewater is discharged into Makera drain [6].

Unlike river Kaduna where studies relating to heavy metal levels had extensively been investigated, there is scanty information on the heavy metal concentration of Makera drain. Therefore, this study was designed with the aim to determine the levels of some heavy metals in the drain.

MATERIALS AND METHODS

Study area

Makera drain industrial area is located on the far East (Nnamdi Azikwe) western bye–pass road in Kaduna. Notable industries located there are United Nigeria Textiles Plc (UNT Plc), Changchangi oil depot, Zamfara Textiles, Nigerian Brewery Ltd (NBL) and Norspin (Fig 1). These industries drain into the Makera rivulet, that drains northwards and empties into River Kaduna, a 10^{th} order river, which flows across Kaduna metropolis, it serves as a major source of water supply to its populace and many aquatic organisms.

Water sampling

Water samples were collected monthly from August 2003 to February 2004, at four sampling points (Fig 1). Site 1 is a tributary that receives domestic wastes. Site 2 is the beginning of Makera drain, and receives effluent from KTL. Site 3 is the confluence of the tributary and the main drain, while Site 4 is the

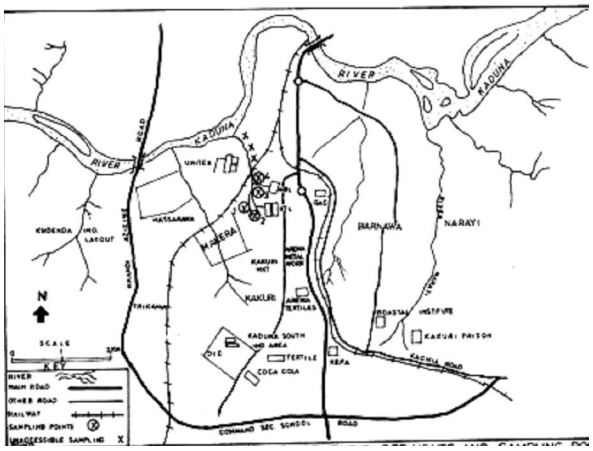

Figure 1: Study areas showing industries and sampling points

downstream which receives effluents from NBL, Changchangi oil depot and Norspin. Although other sampling points were designated at the initial stage of this study, they were however inaccessible due to flooding (marked 'X' on Fig. 1).

Water samples were collected from the four sampling points, in clean dark two-litre plastic jar with screw caps, placed in a box containing ice and transported to Kaduna Refinery and Petrochemical Laboratory (KRPC) for analysis.

Determination of Fe, Cu, Cr, Zn, Cd and Pb.

Digestion of samples was carried out based on the method described by [7] and [8], and the metal concentration was determined using Atomic Absorption Spectrophotometer (AAS Philips Unicam 969) at KRPC and National Research Institute for Chemical Technology, Basawa-Zaria, Nigeria.

RESULTS

The monthly variations in Fe, Cu, Cr, Zn, Cd and Pb over time are presented in Fig 2. Generally, the concentration of the metals were found to be Fe>Cr>Cu>Pb>Zn>Cd in that order of decreasing magnitude.

Mean Fe concentration was highest in Site 1 (133.33mg/l), and lowest in Site 3 (1.06mg/l). Copper concentration was highest in site 4 (3.26mg/l) and lowest in site 1 (0.07mg/l). The highest and lowest concentrations of chromium were 3.33mg/l and 0.9008mg/l in Site 3 and 1 respectively. Zinc had the highest concentration (2.08mg/l) in Site 3, and lowest (0.05mg/l) in Site 2. The highest concentration of cadmium (0.41mg/l) was in site 4, while Site 1 had the lowest (0.01mg/l). Lead concentration was highest in Site 1 (3.0mg/l), and lowest (0.001mg/l) in Site 2.

The highest concentration of iron (133.33mg/l) was in November and the lowest (1.72mg/l) in December (both in the dry season). The highest monthly copper concentration (1.88mg/l) was in September (wet season), the lowest 0.24mg/l in December (dry season). The highest value of chromium (3.04mg/l) was in February and the lowest (0.03mg/l) in November (dry season). The highest value of zinc (1.03mg/l) was in October (wet season) while the lowest concentration (0.01mg/l) was in December (dry season). Cadmium concentration seemed to be low throughout the year compared to other heavy metals, the highest (0.21mg/l) was in September (wet season) and the lowest (0.01mg/l) in December (dry season). The highest concentration of lead (1.96mg/l) was in January (dry season), while the lowest (0.11mg/l) in October (wet season).

Analysis of variance (ANOVA) showed high significant variations ($P<0.01$) between sites, months and seasons for all the heavy metals determined except for Zn, which vary significantly between months at ($P<0.05$) and insignificantly ($P>0.05$) between seasons.

DISCUSSION

The concentration of the heavy metals determined in Makera drain (except Zn) exceeded the internationally recommended desirable levels for drinking water. The high concentration of Fe, Cu, Cr, Cd and Pb may be attributed to various sources, some of which include automobile tire dust, burning of oil and tyre, plastic wrappings, paints, dyes, and especially, effluents from food and beverages and textile factories that discharges their effluent directly into Makera drain. High levels of these metals in surface water of some Nigerians water bodies were reported by [9-12]. The control of solubility of Fe and Zn, involves mineral equilibrium controlled by pH [13]. A decrease in pH favours the retention time of some metals in free water [14], while the soil of the catchments area and subsurface flow influence elemental behaviour [15]. Although, the concentration of Fe is the highest amongst the metals but it is an essential nutrient of the blood and skeleton; digestion of large amounts can lead to its accumulation in the body leading to tissue damage and hyperhaemoglobularia [16].

The increase of copper concentration at site 4 may be due to its eventual concentration after the drain received all discharges from the industries. The high concentration of copper during the tail end of the wet season in the present study conforms to the report on the seasonal variations of heavy metals in the Warri

River [17]. The high value of chromium in Site 3 may be attributed to its presence in soaps and detergents used for washings at homes and dyes from textile. Chromium (III) compounds are less damaging to the health due to their limited absorption by the body (<1%), but chromium (VI) compounds are acutely poisonous and on contact with the skin, it triggers dermatitis, allergies and

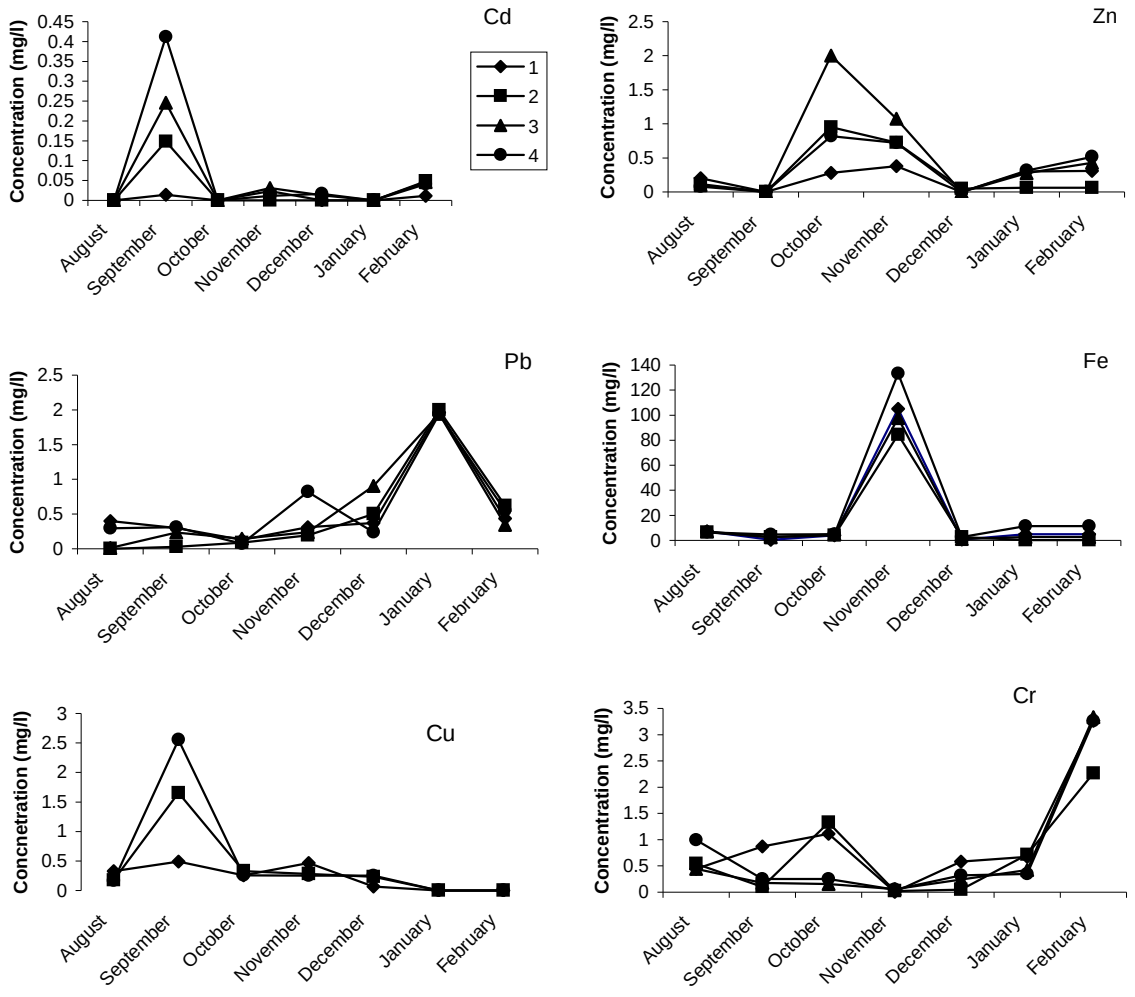

Figure 2: Monthly variation in the concentrations of the metals in water for the period August to

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Table 1: Analysis of Variance (ANOVA) for heavy Metals in water of Makera Drain, Kaduna

Source of Variations	DF	Mean Square					
		Cd	Zn	Pb	Fe	Cu	Cr
Treatment	10	0.016**	0.415**	1.829**	3690.807**	1.542**	3.601**
sites	2	0.004**	0.165**	0.290**	103.375**	0.253**	0.296**
Month	6	0.022**	0.605*	2.143**	5924.4310**	1.923**	5.475**
Season	1	0.018**	0.024	6.161**	3723.680**	3.118**	4.609**
Error	17	0.003	0.094	0.001	0.004	0.035	0.003
Total	37	0.063	1.303	10.163**	13442.297	6.871	13.984

*, **, Indicate Significance at 5% and 1% probability level respectively.

irritations, thus considered as carcinogenic to humans [18].

The values of Zn at all the Sites were below the 5.0mg/1 highest desirable level in drinking water, hough this may not pose immediate visible damage, however when it accumulates, it becomes problematic to aquatic ecosystem [19]. The zinc concentration also imply a contamination from domestic, industrial and

agricultural waste, and the presence of punctual and irregular quantities of Zn in the atmosphere are from incineration which returns to earth in precipitation [20]

Cadmium level in the drain was above the detection limit of 0.001mg/1 and WHO level of 0.01mg/1 in drinking water. This can pose problem for domestic users who were actually seen using the water to wash cars, for irrigation and other domestic purposes. Cadmium has been linked with a number of health problems including renal tubular dysfunction, pulmonary emphysema, significant kidney damage and possibly osteoporosis in people that drank water contaminated by this metal and women exposed environmentally or occupationally can have high levels of Cd and Pb in their breast milk [21]. Moreover, in 1993 the International Agency for Research on Cancer (IARC) classified Cd and its compounds of Cd as carcinogenic.

The concentration of Pb was above the WHO limit of 0.01mg/1, consequently the direct use of water for drinking from this drain by the downstream dwellers without treatment could be detrimental to their health, as it may result in possible neurological damage to foetuses , abortion and other complication in children under three years old [22].

CONCLUSION

Concentrations of heavy metals in Makera drain are above the WHO recommended safe limits; therefore the industries located along the drain should be advised to treat their effluent before discharging it into the drain.

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