Analyzing Toxic Heavy Metals in Industrial Discharge: Implications for Public Health

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Abstract- This study investigates the concentration of toxic heavy metals in industrial effluents discharged from the Seven-Up Bottling Company in Edo State, Benin City. Effluent samples were collected from three outlet pipes and analyzed as composite samples to determine the levels of manganese (Mn), copper (Cu), magnesium (Mg), iron (Fe), zinc (Zn), lead (Pb), cadmium (Cd), chromium (Cr), and nickel (Ni). The concentrations detected in the effluent were 6.68 mg/L for Fe, 5.65 mg/L for Zn, 2.23 mg/L for Mn, 2.87 mg/L for Cu, 6.65 mg/L for Ni, 1.49 mg/L for Cd, 4.53 mg/L for Cr, and 1.55 mg/L for Pb. The rank order of the metals by concentration was Fe > Ni > Zn > Cr > Cu > Mn > Pb > Cd. These levels, particularly the elevated concentrations of toxic metals, indicate significant contamination. If discharged into aquatic ecosystems, these effluents pose severe risks to both flora and fauna, with potential adverse implications for public health through bioaccumulation and ecosystem disruption.

I. INTRODUCTION

Environmental pollution is a global problem which has been with man for a very longtime. The environment is the surroundings where humans, plants, animals and micro-organisms live or work. It is composed of the land, the Earth's atmosphere and the water. The Earth's system is defined by the four spheres: the biosphere (living things), the atmosphere (air), the litho-sphere (land) and the hydrosphere (water) which all work in harmony together. During the last hundred years, industrialisation has grown at a fast rate. It has thus increased the demand for exploitation of the Earth's natural resources at a careless rate, which has exacerbated the world's problem of environmental pollution. The environment has been seriously polluted by several pollutants such as inorganic ions, organic pollutants, organometallic compounds, radioactive isotopes, gaseous pollutants and nanoparticles . Heavy metal pollution will be discussed further in this article. However, in Nigeria its impact seem to have just been realized. This is attested by the effort of the present government in tackling the issue in recent times. This has led to the establishment of the Federal Environmental Protection Agency (FEPA) by decree number 58 of 1988, saddled with the responsibility of making and implementing environmental laws and standards in order to protect, restore and preserve the Nigerian environment from all kinds of pollution (Ogan and Nwiika, 1993). The effect of effluent on the aquatic environment resulting from pollution is an issue that can not be overempasized. The pollution in the environment is caused by the pollutant. Waste effluent from industries should be properly treated and requires proper disposal to prevent it from reaching and contaminating water resources. In most cases, this is not practiced due largely to technical and economic reasons (Asuquo, 1989). The concern over water quality relates not just to the water itself, but also to the danger of diffusion of toxic substances into other ecosystems (Pretorius, 2000, Bezuidenhont et al, 2002). Surface water is vulnerable to pollution from untreated industrial effluents and municipal wastewater, run-off from chemical fertilizers and pesticides, as well as oil and lube spillage in the coastal area from the operation of sea and river ports (Odukuma and Okpokwasili, 1997; Krantz and Kifferstein, 1998).

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Portable water for domestic use should be free from pathogenic microorganisms and toxic substances such as heavy metals and hydrocarbons. Drinking water should be odourless, tasteless, colourless and devoid of particulate matter (Reid et al, 1979). The protection of public health requires that people be supplied with water of adequate quality which satisfies the minimum quality standard. Pollution of fresh water bodies (rivers, lakes, ponds and streams) by nutrients is mostly experienced as a result of industrial discharge, municipal domestic sewage disposals, surface runoff from agricultural kinds, underground water and salt water intrusion and inundation (Asuquo and Okorie, 1987). The Rivers close to industries can be subjected to industrial effluent of the seven up company load arising from untreated effluent discharge and some other forms of anthropogenic functions. The alarming concentration of heavy metals discharge of these seven up effluent and lack of information on the responses of aquatic biota (fish fauna) to the waste necessitate this study Therefore, The aim of the study is to characterize heavy metal loads from industrial wastewater of seven up discharge, to ascertain the possible effects on the fish fauna in other to avert any possible discharge into the river.

II. MATERIAL AND METHODS

Before analysis for heavy metals, the effluent and water samples were filtered through Whatman no. 541 filter paper (Whatman, Germany) into 100 ml of prewashed plastic bottles and the analytical grade HCl was used to adjust water pH to 3.5. After that the samples were kept in a room temperature until analysis. Cadmium (wavelength 228.8 nm), Chromium (wavelength 357.9 nm), Copper (wavelength 324.8 nm), Iron (wavelength 271.9nm), Zinc (wavelength 213.9) Nickel, (wavelength 232.0) ,Manganese (wavelength 279.5 nm) and Lead (wavelength 283.3 nm) specific hollow cathode lamps were used to analyze the samples. The heavy metals (Pb, Cd, Cr, Cu, Fe, Zn, Ni and Mn) concentrations in all samples were determined by atomic absorption spectrophotometer (AAS) (Model AA-6800, Shimadzu Corporation, Japan) using an air- acetylene flame with digital read-out system (Kenawy et al., 2000; Loska and Wiechuła, 2003; Tapia et al., 2012).

III. RESULTS AND DISCUSSION

Table 1 Result of Physiochemical Parameters with comparism to WHO Standard

Physiochemical Parameter	Value	WHO Standard	FEPA Standard
Ph	5.12	6.5-8.5	6.9
Electrical Conductivity (µS/cm)	312	100	400

Table 2: results of raw wastewater effluent with comparism to WHO Standard (WHO source;j Pavan Kumar Gautam 2016, FEPA 1992, 2003)

PARAMETERS	VALUES	WHO STANDARD	FEPA STANDARD 2003
Fe3+	6.68	0.3	0.3
Zn2+	5.65	5	3
Mn2+	2.23	0.01	0.05
Cu2+	2.87	1	1
NI2+	6.65	0.05	0.02
Cd2+	1.49	0.003	0.003
Cr6+	4.53	0.05	0.05
Pb2+	1.55	0.01	0.01

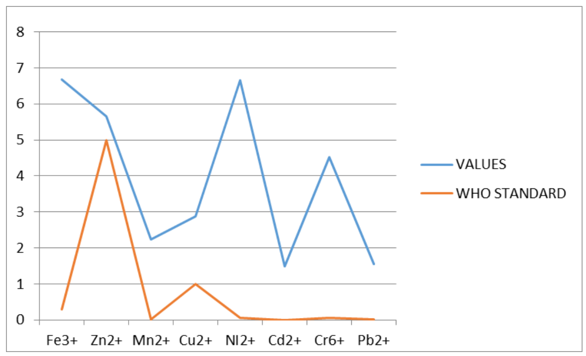

Figure.1Graphical results of raw wastewater effluent with comparism to WHO Standard (source;j a sciortino r ravikumar bobp for fisheries management 1999)

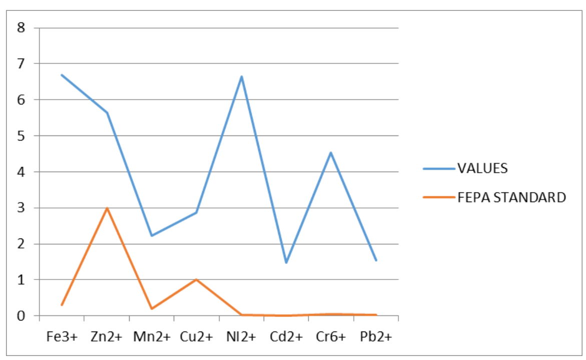

Figure.2 Graphical results of raw wastewater effluent with comparism to FEPA Standard (1992,2003)

IV. POTENTIAL HYDROGEN (PH)

The pH of 5.12 was reported in sample. the low pH of this place is due to the source of the various raw materials used and processing techniques adopted in the factory. Governing authorities need industries to maintain pH discharge limits of 6 to 10. The acidity or basicity of drinking water can have an effect on its makeup. While acidic water is more likely to contain metal contaminants, basic water typically has a high concentration of healthy minerals.

Basic water is said to be healthier than water with a neutral reading, as it prevents acidity in the body from causing chronic illnesses. However, there's not much scientific evidence to back up these claims so far. What we do know is that water with a slightly higher reading of 8 to 8.5 is more likely to have a higher concentration of healthy minerals and electrolytes, like calcium, potassium and magnesium, which the human body needs to survive.

Acidic water, on the other hand, may corrode your teeth, so it is not recommended for consumption. Acid water is also more susceptible to metal leaching, so by drinking water with a low reading, one is more at risk of consuming dangerous levels of copper, lead, and similar contaminants.

Ph between 6.5 and 8.5 for FEPA and WHO respectively is the recommended Ph standard. Anything higher or lower than this is not recommended for drinking. The optimum reading for drinking water is 7. The high acidity of the effluent if not treated can reduce the Ph of surrounding water hence making it harmful for both human and animal consumption.

Electrical conductivity (EC)

the electrical conductivity was found to.Pure water is not a good conductor of electric current rather's a good insulator. Increase in ions concentration enhances the electrical conductivity of water. Generally, the amount of dissolved solids in water determines the electrical conductivity. Electrical conductivity (EC) actually measures the ionic process of a solution that enables it to transmit current. According to WHO standards, EC value should not exceeded 100 µS/cm. The current investigation indicated that EC value was 312 µS/cm which far above 100 µS/cm but falls less than 400 µS/cm of FEPA standsard . In as much as the EC is less than 400 µS/cm for FEPA recommendation, results clearly indicate the effluent in the study area was considerably ionized and has a level of ionic concentration activity due to some dissolve solids.(Table 1)

Levels of heavy metals in Seven up Effluent

Manganese (Mn): Mn plays several roles in physiological processes in living organisms, including humans. It is a major component of enzymes. Potential problems occur when reduced, dissolved Mn(II) is oxidized to insoluble forms, Mn(III) and Mn(IV). If dissolved Mn(II) is in consumer water that enters a building, subsequent interactions with oxidants can lead to water fixture and laundry staining. Also, manganese particles can deposit in plumbing and water-using appliances in a consumer's home or business including water heaters, dishwashers, laundry machines, and water softeners It was seen that in the effluent, the level of Mn was 2.23 mg L-1) (Table 1). From this, it could be accomplished that Mn level found in the waste effluent is not safe because it is higher than the standard value given for Mn by WHO and FEPA which is 0.01 mgL-1 and 0.05 mgL-1 respectively . This may infer that the ingredients or chemicals used in manufacturing or processing are high in Mn composition. From this it is possible to conclude that seven up effluent has relatively high concentration of manganese, and may have effect on the aquatic system if discharged.

Lead (Pb): Pb is both a toxic and non-essential metal having no nutritional value to living organisms. It was seen that in the waste effluent, the level of Pb is 1.55 mg L-1 (Table 1). From this, it could be observed that Pb level found in the study area was greater than the standard value given for Pb by WHO and FEPA which is 0.01 mgL-1.This may infer that raw materials and ingredients used in manufacturing or processing must have played a significant role in the level of Pb in the waste effluent. From this it is possible to close that this effluent has relatively high concentration of Pb, and its effect on the aquatic systems is very high (include Cardiovascular effects, increased blood pressure and incidence of hypertension. Decreased kidney function. Reproductive problems in both men and women) because of Pb is very toxic heavy metal even at low concentration. Thus, the waste effluent should be well treated against Pb before disposing into the surrounding river.

Chromium (Cr): It was seen that in the work site, the level of Cr was 4.53 mg L -1 (Table 1). Thus, Cr concentration in the waste effluent is not complying with the set WHO and FEPA guideline (0.05 mgL-1, for domestic use). It can cause Nausea, gastrointestinal distress, stomach ulcers, skin ulcers, allergic reactions Kidney and liver damage Reproductive problems Lung and nasal cancer Therefore, the seven up effluent should be well treated for Cr before discharge into any surrounding river .

Cadmium (Cd): It was seen that the level of Cr was 1.49 mg L-1 (Table 1). Cd is a non-essential element and is highly toxic to marine and freshwater aquatic life. Cadmium has the chronic potential to cause kidney, liver, bone and blood damage from long- term exposure at levels above the maximum contaminant level (MCL). Cd concentrations in the effluent (Table 3) does not comply with the set WHO and FEPA guideline (0.003 mg L -1, for domestic use) Therefore, the waste effluent should be well treated before discharging into the surrounding.

Copper (Cu) : It was seen that the level of Cu was 2.87 mg L-1 (Table 3). Cu is an essential trace element that is required to maintain good health. Consumption of high levels of copper can cause nausea, vomiting, diarrhoea, gastric (stomach) complaints and headaches.. Cu concentrations in the river water (Table 3) not comply with the set WHO and FEPA guideline (1,0 mg L -1, for domestic use) Therefore, the waste effluent should be well treated for Cu before discharging into surrounding rivers.

Iron (Fe) : It was seen that in the efflueny discharge site, the level of Fe was 6.68 mg L -1 (Table 1). Thus, Fe concentration in the waste effluent is not complying with the set WHO and FEPA guideline (0.3 mgL-1, for domestic use). The high Concentration of Fe might be iron salts used in processing and manufacturing and where cast iron, steel, and galvanized iron pipes are used for water distribution. Iron overload can lead to hemochromatosis — which can cause damage to the liver, heart, and pancreas. It can cause early onset of wrinkles on the skin. Therefore, the seven up effluent should be well treated for Fe before discharge into any surrounding river .

Nickel (Ni) : It was seen that in the efflueny discharge site, the level of Ni was 6.65 mg L -1 (Table 1). Thus, Ni concentration in the waste effluent is not complying with the set WHO and FEPA guideline (0.05 mgL-1,and 0.02 mgL-1 respectively for domestic use). Nickel is necessary in many organism's diets but can become carcinogenic and toxic in high doses. ... When ingested through water, in small amounts, it is harmless to humans and in fact necessary in our diet. Effects of Ni when ingested in high dose are; Contact dermatitis; headaches; gastrointestinal manifestations; respiratory manifestations; lung fibrosis; cardiovascular diseases; lung cancer; nasal cancer; epigenetic effects. Therefore, the seven up effluent should be well treated for Ni before discharge into any surrounding river .

Zinc (Zn): It was seen that the level of Zn was 5.65 mg L-1 (Table 1) Zinc is an essential nutrient needed by the body for growth, development of bones, metabolism and wound-healing. Too little zinc in the diet also can cause adverse health effects such as loss of appetite, decreased sense of taste and smell, lowered ability to fight off infections, slow growth, slow wound-healing and skin sores.Eating or drinking too much zinc in a short period of time can lead to adverse health effects, such as stomach cramps, nausea and vomiting. Eating large amounts of zinc for longer periods may cause anemia, nervous system disorders, damage to the pancreas and lowered levels of “good” cholesterol. Zn concentrations in the effluent (Table 3) does not comply with the set WHO and FEPA guideline (5 mg L -1,and 3 mgL-1 for domestic use respectively) Therefore, the waste effluent should be well treated before discharging into the surrounding.

CONCLUSION

This study revealed that the concentration of heavy metals in the waste water effluent samples of Seven up company Benin City from the various industrial outlets was higher than the permitted heavy metal concentrations of various standards (WHO and FEPA). The results revealed elevated levels of Ni and Fe, compared to other heavy elements in the waste water effluent .The Ph should be buffered to bring the effluent to the range of accepted standard. High EC in the effluents may indicate high concentration of dissolved salts, the industrial effluent should therefore be monitored and properly treated before discharge to streams so as to safeguard the environment.

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