Pollution of Ibadan soil by industrial effluents

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Abstract: Industrial pollution has been and continues to be a major factor causing the degradation of the environment around us, affecting the land we live on, the water we use and the air we breathe. Many industrial activities are responsible for discharging waste into the environment, and these waste containing many poisonous substances that will contaminate the soil. Soil contamination by effluents from nine (9) food processing industries in Ibadan city was the subject of this research. Effluents, receiving water, soil and plants around the industries were sampled and analyzed for levels of pollutants using standard analytical methods. The results shown significant pollutants enrichment of soil by the effluents from the studied industries. Industrial pollution is clearly one of the biggest contributions to our polluted land, at least here in the west; there is need for a stricter regulation of industrial effluents to control soil contamination, in order to reduce the risk to public health. [New York Science Journal 2010;3(10):37-41]. (ISSN: 1554-0200).

Key words: Food Processing, Ibadan, pollution, industries effluent.

1. Introduction

Industrialization is vital to a nation's socio-economic development as well as its political stature in the international committee of nations. If provides ready employment opportunities for good percentage of the population in highly developed economics. Industries vary according to process technology, sizes, nature of products, characteristics and complexity of wastes discharged (Amuda, 2006). Ideally citing of industries should strike a balance between socio-economic and environmental considerations. In developing countries such as Nigeria, citing of industries is determined by various criteria, some of which are environmentally unacceptable, thereby, posing serious threat to public health. Significant in this respect is the establishment of industrial estates alongside residential areas in most state capitals and large urban centers in Nigeria.

Rapid industrial development and the world global growth have led to the recognition and increasing understanding of interrelationship between pollution, public health and environment. While almost industrial activities cause some pollution and produce waste, relatively few industries (without pollution control and waste treatment facilities) are responsible for the bulk of the pollution (WHO, 1982). Mainly, there are three kinds of industrial pollutions affecting the land: construction debris, petrochemical transportation from transport and fuels; and heavy metals and chemicals.

Although industrialization is inevitable, various devastating ecological and human disasters which have continuously occurred over the last four decades, implicate industries as major contributors to environmental degradation and pollution problems of various magnitude (Abdel-Shafy and Abdel-Basir, 1991; Asia and Ademoroti, 2001; Amoo et al., 2004). It has been reported that industrial effluent has a hazard effect on water quality, habitat quality, and complex effects on flowing waters (Ethan et al., 2003). Industrial wastes and emission contain toxic and hazardous substances, most of which are detrimental to human health (Rajaram and Ashutost, 2008; Ogunfowokan et.al. 2005 and Jimena et. al 2008). These include heavy metals such as lead, cadmium and mercury, and toxic organic chemicals such as pesticides, PCBs, dioxins, polyaromatic hydrocarbons (PAHs), petrochemical and phenolic compound (Rao et al., 1998; Njoku et. al., 2009; and Gbadebo et al., 2010).

Realizing the low level of environmental awareness in developing countries, coupled with the non-existence of environmental protection laws, and the abject poverty of these nations, the developed countries have within the last decade, embarked upon "toxic waste trade" or "illegal dumping of toxic wastes" in poor, debt-strapped developing countries. In an attempt to capture the environmental and socioeconomic impacts of industrial effluents irrigation in different industrial locations, Mukherjee and Nelliyat found that the continuous disposal of industrial effluents on land, which has limited capacity to assimilate the pollution load, led to groundwater pollution, which if continues unabated could pose serious problems in the future. Studies regarding the groundwater quality analysis have been made by many authors and concluded that it is the high rate of exploration then its recharging, inappropriate dumping of solid as well as liquid wastes, lack of strict enforcement of law and loose governance are the cause of deterioration of ground water quality (Sandeep and Shweta, 2008).

Another very relevant work by Xia on “An Estimate of the Economic consequences of Environmental Pollution in China” has empirically and quantitatively assessed the impact of environmental pollution. Bhagirath and Ratna (2002) studied the environmental impact of water pollution on rural communities in general and on agricultural production, human health and livestock in particular analyzed some important issues like linkages between industrial development and changes in the micro (local) environment, damage to crops and animal husbandry due to industrial pollution and impact on health and sanitation in rural communities. Setyorini and Ipinmoroti (2001) also noted that soil contaminated by heavy metals may pose a threat to human health if the heavy metals enter the food chain.

The objective of this study is to determine the levels of pollutants in effluents discharged from food industries and their effect on adjoining lands in Ibadan metropolis.

2. Materials and Methods

This study was conducted in Ibadan, South Western Nigeria. Effluents were collected from nine (9) food processing industries which include four (4) confectionery, two (2) oil processing and three (3) beverage industries. Water samples were collected at receiving waters 50 m down and upper the water course adjacent to the effluent carriage system into clean, dry, air-tight polyethylene samples and refrigerated at 4^0C, pending analyses. Water samples collected from upstream before the discharge of the effluent into the stream served as control. Soil samples were collected cross-sectional (using an anger) from three different points at a depth of 15 cm from topsoil located about 50 m from the effluent outfall points of each of the nine (9) food industries; samples were collected at least 500 m from the nearest industry. Freshly collected soil and plant samples from the study areas were air dried, sieved and acid digested before analysis.

The samples were analyzed for physical and chemical characteristics. Temperature was measured using a standard field size thermometer; pH was measured as described by Anderson and Ingram (1989) using a Model 3020 pH meter (JENWAY, UK). A conductivity meter (Model 4010, JENWAY, UK) calibrated with a conductivity standard 0.01 M potassium chloride (KCl) with conductivity 1413 μScm^{-1}) was used for conductivity measurements at 25^0C. In both cases, (physical and chemical characteristic) 20 g of soil samples were weighed and suspended in 50 mL of distilled water and stirred before introducing probe. Heavy metals such as Cobalt [Co], Chromium [Cr], Copper [Cu], Iron [Fe], Manganese [Mn], Lead [Pb] and Zinc [Zn] were determined using atomic absorption spectrophotometer [AAS] Buck Scientific Model 500A as described by Juo (1982), Biochemical Oxygen Demand (BOD), and Chemical Oxygen Demand (COD) were determined as described and APHA (1992). Hardness, turbidity, total dissolved solids, total solids and dissolved oxygen was determined using a flame photometer. Phosphate, nitrate, ammonium and chloride were determined using standard method (APHA, 1992). The results are expressed in mg/L for effluents and receiving water, and mg/kg for soil and plant samples. Means of triplicate readings obtained in the study were subjected to analysis of variance (ANOVA) and Ducan’s multiple range tests using statistical package for social scientist (SPSS) (Oloyo, 2001).

3. Results

The results of the study are presented in Tables 1.

4. Discussion

Mean concentration of heavy metals in effluents, receiving waters, soil and plants from individual confectionery industries, oil processing industries and beverage industries are shown in Table 1, table 2 and Table 3 respectively. Cobalt concentration was the highest in effluent released to the environment. The value obtained in the effluents were significantly ($P < 0.05$) higher than those obtained for receiving waters except for Nigeria Breweries and Quality Foods. There are significant differences ($P < 0.05$) in the soil and plant levels of Co, Cr, Cu, Fe, Mn, Pb and Zn. It is noteworthy that the lead content in soils around the food industries are significantly higher ($P < 0.05$) than the values obtained for effluents, receiving water and plants in the area. Concentrations obtained for effluents from the 9 food industries with respect to Cr, Cu and Pb were within (< 0.1, < 1.00, < 1.00mg/l respectively) recommended by FEPA (1991) and the Chinese Environmental Protection Agency (< 0.5, < 3.0 and < 1.0mg/) (Tang and Ferris, 2000). Values obtained for Zn were higher in effluents from the food industries than the recommend standards. Receiving waters around the food industries had Cr and Zn contents higher than the recommended standard. However, Cu and Pb were within the recommended values. The presence of heavy metals at various concentrations revealed that the effluents from these industries contaminated the soils.

Table 1: Mean concentration of heavy metals from individual confectionery industries effluents, receiving waters, soil and plants.

Industry	Co	Cr	Cu	Fe	Mn	Pb	Zn
Effluent							
Diamond Foods	2.75h±0.08	0.06b±0.01	0.02a±0.003	0.03a±0.004	0.31b±0.01	0.14ab±0.01	0.16b±0.01
Sword Sweets	0.46e±0.01	0.09b±0.01	0.01a±0.002	0.06a±0.01	1.38d±0.04	0.13a±0.01	0.09a±0.01
EFCO	0.60a±0.02	0.10c±0.01	0.01a±0.003	0.02a±0.002	0.09a±0.01	0.12a±0.01	0.07a±0.01
Sumal Foods	2.03g±0.06	0.11c±0.01	0.01a±0.01	ND	0.47c±0.01	0.11a±0.01	0.29c±0.01
RW Upper							
Diamond Foods	0.24c±0.02	0.18b±0.02	0.26c±0.02	1.16d±0.27	1.27d±0.15	0.24c±0.04	0.65c±0.07
Sword Sweets	0.12b±0.01	0.04a±0.01	0.02a±0.01	0.58b±0.23	2.85d±0.59	0.10b±0.01	1.18d±0.12
EFCO	0.28c±0.04	0.06a±0.02	0.14b±0.02	0.73c±0.05	5.33e±0.25	0.10b±0.02	1.87d±0.36
Sumal Foods	0.31d±0.08	0.11b±0.01	0.08b±0.01	0.68c±0.09	5.89e±0.42	0.12b±0.01	1.49d±0.35
RW Lower							
Diamond Foods	0.33d±0.03	0.42e±0.01	0.18bc±0.05	1.74d±0.54	1.51e±0.06	0.11a±0.01	0.84d±0.22
Sword Sweets	0.15c±0.07	0.04a±0.01	0.01a±0.003	0.53b±0.18	3.48f±0.72	0.13a±0.02	1.34e±0.23
EFCO	0.46e±0.05	0.04a±0.01	0.25c±0.02	0.95c±0.18	7.31i±0.16	0.09a±0.01	1.45e±0.23
Sumal Foods	0.37d±0.06	0.08b±0.01	0.12b±0.01	0.95c±0.03	5.75gh±1.65	0.16b±0.02	1.36e±0.23
Soil							
Diamond Foods	0.09bc±0.01	0.11c±0.01	0.56d±0.02	120.11g±3.47	73.95m±2.13	0.92e±0.03	30.91j±0.89
Sword Sweets	0.11c±0.01	0.25d±0.01	3.55d±0.10	376.62k±10.87	65.69l±1.90	9.46h±0.27	24.11i±0.70
EFCO	0.34d±0.01	0.29d±0.01	0.93e±0.03	266.76i±7.70	73.48m±2.12	3.13f±0.09	68.99l±1.99
Sumal Foods	0.52f±0.02	0.18b±0.01	0.84e±0.02	280.58j±8.10	115.92n±3.35	6.68g±0.19	56.30k±1.63
Plants							
Diamond Foods	0.02a±0.001	0.07b±0.01	2.93h±0.08	73.08f ±2.11	9.85j±0.28	0.24c±0.01	8.39h±0.24
Sword Sweets	0.06b±0.01	0.08b±0.01	1.19f±0.03	67.75f ±1.96	5.03gh±0.15	0.10a±0.01	4.68f±0.14
EFCO	0.08b±0.01	0.01a±0.002	2.09g±0.06	211.63h±6.11	21.88k±0.63	0.34d±0.01	5.00fg±0.14
Sumal Foods	0.05b±0.01	0.08b±0.01	0.56d±0.02	61.61e±1.78	4.83g±0.14	0.11a±0.01	5.73g±0.17

Values are means of triplicate readings ± SEM
Means followed by different lowercase letters under each parameter are significantly different ($P < 0.05$)
+ All values are expressed in mg/L for effluent and receiving water and in mg/Kg for plant and soil.
RW: Receiving water

Table 2: Mean concentrations of heavy metals in effluent and receiving waters from individual oil processing industries in Ibadan.

Oil Industry	Location	Co	Cr	Cu	Fe	Mn	Pb	Zn
Best Oils Ltd								
	Effluent	2.08e±0.06	0.06b±0.01	ND	0.01a±0.001	0.43b±0.01	0.10a±0.01	0.04a±0.01
	RW	0.22b±0.01	0.13c±0.01	0.21b±0.01	0.78d±0.02	11.70b±0.34	0.10a±0.01	0.76c±0.02
	RW	0.36c±0.01	0.68e±0.02	0.09b±0.01	0.37c±0.01	10.98b±0.32	0.20b±0.01	1.76c±0.05
	Soil	0.31c±0.01	0.21d±0.01	1.08d±0.03	511.95h±14.78	64.85e±1.87	1.86d±0.05	21.17g±0.61
	Plant	0.07a	0.10	3.53	266.85g	10.58b	0.21b	14.20f
Premier Agro								
	Effluent	0.48d±0.01	0.07b±0.01	0.02a±0.003	ND	0.15a±0.01	0.14a±0.01	0.10b±0.01
	RW	0.17b±0.01	0.05b±0.01	0.14b±0.01	0.19b±0.01	11.67b±0.34	0.08a±0.01	1.46c±0.04
	RW	0.20b±0.01	0.02a±0.01	0.06b±0.01	0.93e±0.03	10.33b±0.30	0.16ab±0.01	2.46d±0.07
	Soil	0.05a±0.003	0.01a±0.005	0.66c±0.02	281.30g±8.12	56.05d±1.62	0.49c±0.01	22.13g±0.64
	Plant	0.05a±0.003	0.07b±0.003	1.07d±0.03	30.82f±0.89	15.09c±0.44	0.11a±0.01	11.68e±0.34

Values are means of triplicate readings ± SEM
Means followed by different lowercase letters in a column under each industry are significantly different ($P < 0.05$)
+ All values are expressed in mg/L for effluent and receiving water and in mg/Kg for plant and soil.
RW: Receiving water

Table 3: Mean concentrations of heavy metals in effluents from individual beverage industries

Industry	Location	Co	Cr	Cu	Fe	Mn	Pb	Zn
FAN Milk	Effluent	0.75b±0.02	0.06a±0.01	0.01a±0.003	0.03a±0.001	1.29b± 0.04	0.13a±0.003	0.08a±0.002
	RW Upper	0.14a±0.01	0.08a±0.02	0.01a±0.001	0.41b±0.03	1.99c±0.11	006a±0.002	0.28b±0.02
	RW Lower	0.24a±0.04	0.10b±0.01	0.09b±0.04	0.54±0.03	1.00b±0.45	0.12a±0.03	0.59b±0.24
	Soil	0.25c±0.01	0.14c±0.01	1.03b±0.03	718.06m±20.73	83.52f±2.41	3.24d±0.09	22.30d±0.64
	Plant	0.10c±0.001	0.11c±0.001	3.42e±0.10	46.42d±1.34	5.65c±0.16	0.34b±0.01	3.51c±0.10
Nig. Brew.	Effluent	0.13a±0.01	0.05a±0.01	0.02a±0.004	0.03a±0.002	0.78a±0.02	0.18a±0.01	0.32b±0.01
	RW Upper	0.19a±0.02	0.03a±0.004	0.04a±0.001	0.25b±0.05	2.80c±0.01	0.10a±0.01	2.48c±0.82
	RW Lower	0.29a±0.04	0.14b±0.05	0.09b±0.02	0.49±0.11	2.86c±0.06	0.15a±0.02	1.49c±0.61
	Soil	0.70f±0.02	0.26e±0.01	0.78b±0.02	121.26g±3.50	187.45h±5.41	14.80f±0.43	60.71f±1.75
	Plant	0.10c±0.001	0.12c±0.01	3.24e±0.09	68.27f±1.97	7.92c±0.23	0.45c±0.01	4.61c±0.13
Quality Foods	Effluent	0.20a±0.01	0.09b±0.01	0.02a±0.003	0.06b±0.001	ND	0.15a±0.01	0.22b±0.01
	RW Upper	0.17a±0.01	0.04a±0.002	0.03a±0.002	0.48b±0.01	4.59d±1.32	0.14a±0.03	1.37c±0.30
	RW Lower	0.19a±0.01	0.05a±0.01	0.04a±0.001	0.65±0.08	2.30c±1.03	1.02b±0.39	0.82c±0.34
	Soil	0.34c±0.01	0.19d±0.01	2.41d±0.07	480.84k±13.88	120.10g±3.47	7.44e±0.21	70.37g±2.03
	Plant	0.08b±0.01	0.12c±0.01	2.36d±0.07	23.64c±0.68	12.62d±0.36	0.11a±0.01	5.23c±0.15

Values are means of triplicate readings ± SEM
Means followed by different lowercase letters in a column under each industry are significantly different ($P < 0.05$)
+ All values are expressed in mg/L for effluent and receiving water and in mg/Kg for plant and soil.
RW: Receiving water

5. Conclusion

This study has shown that receiving water and soil quality are significantly influenced by effluent discharge from the considered industries. The presence of a wide range of components in the effluents from the food and oil industries in Ibadan metropolis underscores the need to further process the effluents prior to discharge into receiving waters. Setyorini et al (2001) suggested that the remediation of soil contaminated by lead and cadmium could be carried out by growing water hyacinth or retriever grass which would reduce significantly, the levels of these heavy metals in the soil.

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