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DETERMINATION OF THE LEVEL OF SOME HEAVY METALS IN WATER COLLECTED FROM TWO POLLUTION – PRONE IRRIGATION AREAS AROUND KANO METROPOLIS

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ABSTRACT
Industrial effluents discharged into the environment pose a serious threat to our agricultural products and health. In view of this, levels of some heavy metals, Zn, Pb, Cr, Cu, Ni, Co, Ag, Fe and Mn were determined in water samples collected from two pollution prone areas around Kano (Sharada and Bompai industrial estates) and control site (Thomas Dam, Dambatta). The levels of the heavy metals were determined by Atomic Absorption Spectrophotometry. The results obtained show that the mean values of all heavy metals (with the exception of Zn) in water samples from the polluted areas studied were significantly higher than in the control site (P < 0.05). These mean values have also exceeded the acceptable limits.

Key words: Heavy metals, Pollution, Kano, Environment

INTRODUCTION

In Nigeria, the major sources of heavy metals pollution are industrial effluents discharged from various processing industries. This increases the influx of metals, which can be transported by wind and water and thus become available to plants and animals. These heavy metals attain higher concentrations and accumulate in dangerous quantity in different plants' part, and finally pose serious health hazard to human beings and the animals through biomagnification (Ray, 1990).

Heavy metals are elements having atomic weight between 63.545 and 200.5g (Kennish, 1992) and a specific gravity greater than four (Connel *et al.,* 1984). The toxicity of these metals has also been demonstrated throughout history: Greek and Roman physicians diagnosed symptoms of acute lead poisoning long before toxicology became a science. Exposure to heavy metals has been linked with developmental retardation, various cancers, kidney damage and even death (Abdulaziz and Mohammed, 1997).

A legacy of incident tells us about the seriousness of high levels of exposure to some metals, especially cadmium and methyl mercury (Nriagu, 1992). In the 1950s, chronic poisoning from rice coupled with dietary deficiencies caused epidemic of kidney damage and a painful skeletal disease among middle – aged women in Japan; the *itaitai* disease (Nriagu, 1992). Also in Japan, mercury poisoning from fish in a polluted bay became known as Minimata disease (Nriagu, 1992).

Industrial pollution seriously threatens the quality of water resources and the environment in Kano. For instance, the deposition of refuse from food industries has been reported to have contaminated water from virtually all the boreholes in Bompai industrial estate (Egboka *et al.,* 1989). The incidence of water discharge is possibly the biggest threat to city farming and has been identified as a major environmental hazard in the region (Tanko, 2002).

A study conducted in 1989, which monitored the activities of 15 tanneries in Kano revealed that in all cases, permissible limits for effluents discharged were violated (World Bank, 1995). The same study indicated that not only do downstream fish and crops become heavily contaminated by heavy metals, but human health is further threatened in Kano, because over 60% of the local people depend on rivers and ground water for their domestic use.

Thus, from the studies highlighted above, it can be said that industrial pollution in Nigeria poses a serious threat to human beings. It needs to be tackled from every angle simultaneously using industrial technology, biotechnology, legal measures and environmental awareness education.

It is therefore, quite imperative to conduct various researches with the view to exploring all sources of heavy metal pollution in the environment. This may lead to the discovery of the presence of heavy metals and other contaminants and equally the levels at which they occur and their possible mode of control.

MATERIALS AND METHODS

Sample Collection

The method employed by Environmental Protection Agency as reported by Gregg (1989) was adopted for the collection of water samples. The immediate source of water for the irrigation was used. The sources include the effluents pumped by the farmer's machines for irrigation and also from the channels leading away from the industries. The water from the control site was directly collected from the dam and then from the channels leading to the farmlands.

The composite samples of water were collected in prerinsed plastic containers and mixed to make representative samples.

Digestion of Water Sample

The EPA vigorous digestion method described by Gregg (1989) was adopted. 100ml of each of the representative water samples were transferred into Pyrex beakers containing 10ml of concentrated HNO_3. The samples were boiled slowly and then evaporated on a hot plate to the lowest possible volume (about 20ml). The beakers were allowed to cool and another 5ml of Conc. HNO_3 was added. Heating was continued with the addition of Conc. HNO_3 as necessary until digestion was complete. The samples were evaporated again to dryness (but not baked) and the beakers were cooled, followed by the addition of 5ml of HCl solution (1:1 v/v). The solutions were then warmed and 5ml of 5M NaOH was added, then filtered. The filtrates were transferred to 100ml volumetric flasks and diluted to the mark with distilled water. These solutions were then used for the elemental analysis.

Metal Analysis

A total of nine metallic elements were determined in the pre – treated samples of water using Atomic Absorption Spectrophotometry as described by Gregg (1989). These include Zn, Pb, Cu. Co. Ni, Cr, Ag, Fe and Mn.

RESULTS

The mean values of heavy metals analysed in the water samples from the three sampling sites are presented in Table 1.

Table 1: Content of Heavy Metals in Water Samples from the study sites (mg/l)

Metal	Site A	Site B	Site C
Zn	0.260 $\pm$ 0.01	0.257 $\pm$ 0.02	0.225 $\pm$ 0.02
Fe	0.108*** $\pm$ 0.05	0.217*** $\pm$ 0.03	0.080 $\pm$ 0.01
Pb	1.74*** $\pm$ 0.05	1.538*** $\pm$ 0.18	0.154 $\pm$ 0.06
Cu	0.284*** $\pm$ 0.02	0.345*** $\pm$ 0.03	0.050 $\pm$ 0.01
Ni	0.208** $\pm$ 0.02	0.453*** $\pm$ 0.03	0.056 $\pm$ 0.01
Cr	1.032** $\pm$ 0.21	1.214** $\pm$ 0.14	0.242 $\pm$ 0.06
Co	0.354*** $\pm$ 0.015	0.191** $\pm$ 0.01	ND
Ag	1.032*** $\pm$ 0.03	1.504*** $\pm$ 0.07	0.120 $\pm$ 0.04
Mn	0.892*** $\pm$ 0.02	0.739*** $\pm$ 0.01	0.112 $\pm$ 0.001

Values bearing *, **, *** are significantly different as compared to site C at $p < 0.05$, $p < 0.01$ and $p < 0.001$.
Key: A = Sharada industrial area, B = Bompai industrial area, C = Thomas Irrigation Dam, Dambatta (Control)
ND = not detectable

Table 2: WHO Standard for Fresh Water

	WHO Standard	
Metal	**MAC (mg/dm^3)**	**MPL (mg/dm^3)**
Cu	0.05	15.0
Cr	0.05	-
Pb	0.05	0.10
Zn	5.0	15.0
Cd	0.005	0.01

Source: Olajire and Imeokpara (2000).
Key: WHO = World Health Organization, MAC = Maximum Admissible Concentration, MPL = Maximum Permissible Level

The metals can be arranged in descending order of their concentration from the pollution prone areas (i.e. sites A and B); Pb > Cr > Ag > Ni > Co > Cu > Zn.

From the statistical analysis of the data, using t – test operated by Special Programmes for Social Sciences (S.P.S.S), it was found out that the mean values of all heavy metals (with the exception of Zn) analysed at site A differ significantly ($p < 0.05$) from those of site C (control). Comparing the metal content of site B with that of site C, it was discovered that all heavy metals (with the exception of Zn) in site B differ significantly from those analysed in site C ($p < 0.05$).

DISCUSSION

From the results obtained, it is clear that the water from the industrial effluents in the areas studied had larger content of heavy metals capable of polluting the environment. The absence of detectable level of Co in site C suggests that the Co in sites A and B might have come from the industrial effluents. The levels of some heavy metals from site A, i.e. Cu, Co, Ni, Fe, Mn, Ag differ significantly ($p < 0.05$) from those in site B. This may explain the degree of variation of pollution from the sources of heavy metals in the two locations. This indicates that site A is more polluted than site B. Lead (Pb) was found to be the heavy metal with highest concentration in both sites. This implies that there is high level of Pb disposal in the effluents in the study areas, which may be attributed to the large number of tanning industries found in both areas. Lead is normally found in dyes and pigments used in industries (Ademorati, 1992). The results obtained in this study indicated that the mean values of Zn in sites A and B is below the maximum allowed concentration, while that of Cr is above this level (as a criteria for World Health Organization for fresh water (Olajire and Imeokparia, 2000).

The mean values of Cu from both sites A and B were found to be above the maximum allowed concentration (Table 2). Similarly, the mean value of Pb from the polluted areas was above the maximum permissible level.

The results for other remaining heavy metals analysed indicated that they are below the upper limit of maximum admissible concentrations. Although high level of heavy metals was discovered in the areas under study, yet there are some factors affecting their absorption by the soil and of course their availability to the plants.

These findings imply that consumption of the polluted water by animals or human beings could be hazardous to their health. Soil contaminated by these effluents will produce unhealthy food as heavy metals can enter the food chain and thus be consumed by human beings. For instance, the mean values of Pb from the polluted areas, which was found to be above the maximum permissible level could exert toxic effects on human beings if consumed from the water or irrigated agricultural products from the sites.

Lead interferes with functions performed by essential mineral elements such as calcium, iron, copper and zinc. It also inhibits red blood cell – enzyme systems (Vasudevan and Streekumari, 2000).

Similarly, lead can displace calcium in bone to form softer denser spots. It also inactivates cysteine containing enzymes, allowing more internal toxicity from free radicals, chemicals and other heavy metals (Underwood, 2002).

Moreover, hyper reactivity and learning disorders have been correlated with lead intoxication in children. A relationship between lead levels and learning defects (like day dreaming as well as being easily frustrated or distracted) was found to exist. Other defects include decrease ability to follow instruction and poor learning focus in children (Underwood, 2002).

It may be concluded that the areas under study have been polluted by the industrial effluents from the industries surrounding them.

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