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Assessment of Heavy Metals in Drinking Water (Hand Dug Well) in Oye Ekiti, Nigeria

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Abstract: ***The purpose of study was to assess heavy metals (Fe, Cd, Pb, Zn, Ni) in drinking water. Twenty samples were analysed using atomic absorption spectrophotometer. The result show that the average heavy metal levels in all water samples followed a descending order: Zn>Fe> Pb > Ni> Cd. It was observed that heavy metals investigated exceeded the maximum permissible limit in drinking water as specified by regulatory bodies except cadmium which was below standard. Pollution index result confirmed significant pollution in Pb, Ni and Fe.***

Keywords: Heavy metals, Drinking water, permissible limit, pollution index

1. Introduction

The increasing consumption and exploitation of the earth's raw materials (fossil fuel and minerals) coupled with the exponential population growth over the past years have resulted in environmental degradation and build up of waste products of which metals is of great concern (1,2).

The term "heavy metals" refers to any metallic element that has a relatively high density and is toxic or poisonous even at low concentration (3). "Heavy metals" is a general collective term, which applies to the group of metals and metalloids with atomic density greater than 4 g/cm3 , or 5 times or more, greater than water (4,5,6,7,8,9). However, being a heavy metal has little to do with density but concerns chemical properties.

Heavy metals include lead (Pb), cadmium (Cd), zinc (Zn), mercury (Hg), arsenic (As), silver (Ag) chromium (Cr), copper (Cu) iron (Fe), and the platinum group elements. It is believed that the great majority of heavy metals act as a key components of essential enzyme systems or other proteins, e.g. . The haemoprotein hemoglobin which performs vital biochemical functions (10,11). Zinc cadmium , lead etc are highly toxic for human bio-system even at very low levels of intake and they are usually present in plants because of the increasing industrialization and associated pollution at the biosphere, taken up from the soil, water, fertilizers, pesticides treatment and anthropogenic operations (12,13). Factories and human social and agricultural activities have an effect on environmental pollution and the ecosystem. The corruption of the ecosystem has a negative effect on human health and on all living Organisms (12, 13,14).

Trace metals, among a wide range of contaminants, are consistently of health concern due to their toxicity potentials at very low concentrations, and tendency to bioaccumlate in tissues of living organisms over time (15). They gain entrance into human systems via contaminated drinking water, food and air. Once in the body, the bioavailable form of these metals can compete with, and displace essential minerals such as zinc, copper, magnesium and calcium; and interfere with organ system function (16).

Drinking water sources in these so-called developing countries are under increasing threat from contaminations by chemical, physical and microbial pollutants. Known sources (both naturally occurring and anthropogenic) of chemical contamination of water supplies include organic and inorganic substances from industrial effluents, municipal wastes, petroleum derived hydrocarbons, detergents, mining, agricultural pesticides and fertilizers (17,18).

According to a recent report by WHO/UNICEF, about 780 million people in the developing world lack access to potable water due largely to microbiological and chemical contaminations (19). Drinking water sources in these so-called developing countries are under increasing threat from contaminations by chemical, physical and microbial pollutants. Known sources (both naturally occurring and anthropogenic) of chemical contamination of water supplies include organic and inorganic substances from industrial effluents, municipal wastes, petroleum derived hydrocarbons, detergents, mining, agricultural pesticides and fertilizers (3, 4).

Therefore, this research work was aimed at assessing the concentrations of Fe, Cd, Pb, Zn and Ni in hand dug well drinking water sources. Also, to determine the heavy metal pollution indices as well as compare the observed concentrations with the water quality permissible limits specified by the regulatory bodies.

2. Materials and Methods

A. Description of Study Area

Oye Ekiti is a town and headquarters of Oye Local Government Area in Ekiti state, western Nigeria. It has a geographical coordinates of 7°8′00″N and 5°33′00″E . The major occupation of the inhabitant is farming. Their major sources of water are underground and rivers.

B. Sample Collection, Pre-Treatment and Chemical Analysis

Twenty water samples were randomly collected within Oye Ekiti in Ekiti state. Samples were collected in 1L polyethylene container. The sample containers were washed with 20 % analytical grade nitric acid and rigorously rinsed

with distilled deionized water. Prior to sampling, it was further rinsed with the actual sample. Collected samples were preserved by chemical adjustment of the pH < 2, by acidifying with 5 milliliters of analytical grade nitric acid. This reduces precipitation and sorption losses to the container walls. After which the samples were stored under ice on transit and then refrigerated after arriving at the laboratory at a temperature of (4°C) prior to analysis. The water samples and reagent blank were digested using concentrated nitric acid (HNO3) for the determination of metal ions concentration and was further analysed using VGP 210 (Buck Scientific)atomic absorption spectrophotometer (AAS). Also, prior to metal ion analyses, calibration solutions of the target metal ions were prepared from standard stock by serial dilution. Quality assurance and control was performed according to the specified method of (20).

C. Pollution Index (Pi)

Pollution index (Pi) is defined as the ratios of the concentration of individual parameter against the baseline standard. It provides information on the relative pollution contributed by individual samples. The critical value is 1.0, values greater than 1.0 indicates significant degree of pollution while values less than 1.0 shows no pollution (21, 22). Pi is computed as:

$$P_i = \frac{\text{Concentration}}{\text{Standard}}$$

RESULTS AND DISCUSSIONS

To assess the potability and safety of water for drinking purpose, the concentrations of heavy metals in the present study were compare with the regulatory bodies standard for drinking water quality.

Table 1: Concentration of heavy metals in drinking water (hand dug well).

Sample Code	*Fe (ppm)*	*Cd (ppm)*	*Pb (ppm)*	*Zn (ppm)*	*Ni (ppm)*
1	0.45	BDL	0.31	BDL	0.08
2	0.03	0.01	0.27	BDL	BDL
3	3.08	BDL	0.30	BDL	BDL
4	BDL	0.01	0.35	BDL	BDL
5	0.71	0.01	0.17	BDL	BDL
6	1.50	0.01	0.31	BDL	BDL
7	0.05	0.01	0.35	BDL	BDL
8	BDL	BDL	0.34	BDL	BDL
9	BDL	0.01	0.27	BDL	BDL
10	BDL	BDL	0.34	BDL	BDL
11	0.08	BDL	0.45	BDL	BDL
12	0.06	BDL	0.31	BDL	BDL
13	0.01	BDL	0.20	BDL	BDL
14	BDL	0.01	0.41	BDL	BDL
15	BDL	BDL	0.10	1.04	BDL
16	0.75	BDL	0.24	9.90	BDL
17	0.25	0.01	0.27	0.06	BDL
18	0.01	0.01	0.24	0.03	BDL
19	BDL	BDL	0.32	0.03	BDL
20	0.28	0.01	0.31	0.18	BDL
Average	0.36	0.01	0.29	1.87	0.08

BDL= Below Detection Level

Table 2: showing the regulatory body standard for drinking water

ELEMENT	*SON*	*WHO*
Fe	0.30	-
Cd	0.02	0.07
Pb	0.01	0.01
Zn	3.00	-
Ni	0.02	0.07

SON= Standard Organization of Nigeria
WHO= World Health Organization.

Table 3: Pollution Index for the metal ions

Parameter	*Pollution Index*
Fe	1.20
Cd	0.50
Pb	29.0
Zn	0.62
Ni	4.00

The result as shown in table 1 indicate that all the heavy metals i.e Fe, Cd, Pb, Zn and Ni assessed are above the regulatory body standard for drinking water.

The excessive concentration of Fe may be attributed to rocks and soil containing iron, which can dissolve into the water source. Even though iron poses no danger to health at levels found in drinking water, it may affect acceptability of drinking water by altering its appearance, taste, odour, stain clothing and appliances and promote the growth of iron bacteria in the water system (23).

Pb concentration is above the permissible level which could be associated with the corrosive water effects on household plumbing systems containing lead in pipes, solder, fittings or the service connections to homes. It can also be attributed to anthropogenic activities.

The concentration of Ni and Cd as shown in Table 1 were found relatively in low concentrations in all the samples.

The concentration of Zn as shown in Table 1 were found relatively in low concentrations in all the samples except sample 16 which may be attributed to household plumbing systems.

The pollution Index value is presented in Table 3. The values obtained for iron, cadmium, lead, zinc and nickel in all the samples investigated revealed that some of the waters sources were polluted. Amongst the five metals, significant degree of pollution was seen in lead, iron and nickel. This confirms the results on trace metals above permissible limit (Fe, Pb and Ni), for the different water sources as discussed above.

3. Conclusions and Recommendations

The result show that the average heavy metal levels in all water samples followed a descending order: Zn>Fe> Pb > Ni> >Cd in the observed water sample (Table 1) exceeded the maximum permissible limits in drinking water except Cd as specified by WHO and SON standards. Also, the pollution index result obtained confirmed significant pollution in lead, nickel and iron. It is therefore suggested

and advised that the concern contaminated sources be subjected to further treatments that will reduce the concentration of these identified heavy metals which are capable of causing life threatening diseases to the consumers. General public are advised to test their drinking water sources periodically.

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