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Determination of Heavy Metals and Physiochemical Parameters in Water Samples from Gold Mining Area of Yar'galma Village

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ABSTRACT

Artisanal mining activities in some rural areas of Zamfara State have resulted into many health issues associated with heavy metals pollution. This study was conducted to analysed the physicochemical properties and level of heavy metals in sample of polluted water by artisanal mining activities of Yar'galma Village of Bukkuyum L.G.A of Zamfara State. The sample were analysed for six 6 heavy metals (Cu, Zn, Pb, Ni Cd and Cr) using Atomic Absorption spectrometer. The heavy metals were detected in the water samples except for Cadmium in sample A and Lead and Cadmium in sample B. The results were compared with the permissible limit of World Health Organization (WHO) and they were all above the limit set by WHO. Finally, due to the high concentration of these heavy metals detected in the samples which may be related to local and illegal mining taking place close to the village, the water is not safe for drinking.

Keywords: Heavy metals, Water, Mining, pollution, Quality.

1.0 INTRODUCTION

Groundwater is considered among the healthiest sources of water, but domestic, agricultural and industrial activities have led to the degradation of groundwater quality in different part of the world, ground water contamination is responsible for water related and water borne diseases in developing countries like Nigeria, evaluation of ground water quality for human consumption is essential to existence. The source of ground water contamination could be natural through ground water-rock interaction through anthropogenic which involves human activities that can affect ground water quality, ground pollution which is manmade is worse than natural pollution as it eventually renders water unsuitable for use than its original state (Abimbola et al., 2005)

The water pollution by heavy metals has become a question of considerable public and scientific concern in the light of evidence of their toxicity to human health and biological system (Anazawa et al., 2004). Heavy metals receive particular concern considering their strong toxicity even at low concentrations (Marcovecchio et al., 2007). They exist in water in colloidal, particulate and dissolved phases (Adepoju et al., 2009) with their occurrence in water bodies being either of natural origin (e.g. erode minerals within sediments, leaching of ore deposits and volcanism extrude products) or of anthropogenic origin (i.e. solid waste disposal, industrial or domestics effluents) (Marcovecchio et al., 2007). Some of the metals are essential to sustain life such as calcium, magnesium, potassium and sodium must be present for normal body functions. Also, copper, cobalt, iron, manganese, molybdenum and zinc are needed at low level as catalyst for enzymes activities (Adepoju et al., 2009).

Heavy metals are associated with urban municipal waste and very harmful to human life. The Increased in urbanization and industrialization are major contributing factors to heavy metal pollution in our environment (Adepoju et al., 2009). Many dangerous chemical elements if released into environment, accumulate in the soil and sediments of water bodies (Abida et al., 2009). Toxicity level depends on the type of metal, its biological role and the types of organism that are exposed to it (Adepoju et al., 2009). heavy metals have a marked effect on the aquatic flora and fauna which through bio-magnification enters the food chain and ultimately affects the human beings as well (Lokhande et al., 2011). The heavy metals in drinking water linked most often to human poisoning are mercury (Hg), cadmium (Cd), arsenic (As), chromium (Cr), thallium (Tl), zinc (Zn), nickel (Ni), copper (Cu) and lead (Pb), they are required by the body in small amounts but also be toxic in large doses. They constitute one important group of environmentally hazardous substances if present (Marcovecchio et al., 2007). Heavy metals like copper are essential trace elements but show toxicity if in excess amount in drinking water, cadmium is extremely toxic even in low concentration, and a long biological half-life in human body ranging from 10 to 33 years, long term exposure ta cadmium also induced renal damage. So, cadmium is considered as one of the priority pollutants from monitoring in most countries and international organizations. The contamination of water is directly related to water pollution. There is need to continuously assess the quality of ground and surface water sources (Anazawa et al., 2004). The fetal effects of heavy metal toxicity in drinking water include damage or reduced nervous function and lower energy level. They also cause irregularity in blood composition, badly affects vital organs such as kidney and liver (Marcovecchio et al., 2007). The long-term exposure to these metals result in physical, muscular, neurological degenerative processes that cause Alzheimers disease (brain disorder), parkinsons disease (degenerative disease of the brain), muscular dystrophy (progressive skeletal muscle weakness), multiple sclerosis (a nervous system disease that affect brain and spinal cord). Ground water is used for domestic and industrial water supply and also for irrigation purpose in many places over the world. In the last few decades, there has been a tremendous increase in the demand for fresh water due to rapid growth of population and the accelerated pace of industrialization. According to W.H.O about 80% of all diseases in human being are caused by water (Marcovecchio et al., 2007).

The inorganic chemical holds a greater portion as contaminants in drinking water in comparison to organic chemicals (Azrina et al., 2011). A part of inorganics is in minerals form of heavy metals, heavy metals tend to accumulate in human organs and nervous system and interfere with their normal functions. In recent years, heavy metals such as lead (Pb), arsenic (As), magnesium (Mg), nickel (Ni), copper (Cu), and zinc (Zn) have received a significant attention due to causing health problems (Oseni et al, 2013). Moreover, the cardiovascular diseases, kidney disease, neurocognitive disease and cancer are related to the traces of metals such as cadmium (Cd) and chromium (Cr) are reported in epidemiological studies (Oseni et al, 2013)., the lead (Pb) is known to delay the physical and mental growth in infants, while arsenic (As) and mercury (Hg) can cause serious poisoning with skin pathology and cancer and further damages to kidney and liver respectively (Oseni et al, 2013).

This work is designed to determine the level of some heavy metal's contamination (Cr, Cd, and Pb) and physio-chemical parameters in ground water from Yar'Galma village of Bukkuyum L.G.A of Zamfara state.

2.0 PROCEDURE

2.2 Sampling

The water samples were collected in two different areas of YarGalma village of Bukkuyum Local Government Area, Zamfara state (12°08′00″N 5°28′00″E in the north-west of the area). The samples were collected and labeled as A and B, where sample A is the water from mining area and sample B is the water from town. Sample A was collected at the mining area with polyethylene bottle with a capacity of 1 liter. While sample B was collected from a well located 500m away from mining site using a different polythene bottle.

2.2.1 Determination of Turbidity

Exactly10cm^3 of each water sample was measured and poured into the bottle of turbidity meter. The lid from the turbidity meter was opened and the bottle was put into the compartment and the covered, the red button was pressed, the result was displayed and was recorded.

2.2.2 Determination of Electrical Conductivity

Exactly 50cm^3 of each water sample was measured and poured into the beaker, the electrode of the conductivity meter was put into the beaker containing the water sample, the conductivity meter was on and then displayed reading for the analysis. The red button was pressed and the reading was displayed and was recorded.

2.2.3 Determination of total dissolved solids (TDS)

Empty petri dish was weighed; 100cm^3 of water sample was measured and poured into the empty petri dish. The petri dish was placed in an oven to dry completely at 180oc and removed from the oven, it was allowed to cool, the petri dish plus the dry residue were weighed and the reading was recorded.TDS was calculated using Equation 2.1 .

$$TDS\left(\frac{mg}{L}\right) = (weight\ of\ petridish\ plus\ dry\ residue) - (the\ weight\ of\ empty\ petridish) \times 100$$
…………………………………………..2.1.

2.2.4 Determination of dissolved oxygen (DO)

Exactly 200cm^3 of water sample was measured and poured into a bottle, 1cm^3 of $MnSO_4$ solution was added from the pippete and also in the same way 1cm3 of alkali-iodide-azide solution was added, the mixture was shaked well. The precipitate formed was allowed to settle and the clear liquid was decanted. 2cm^3 of concentrated H_3PO_4 was added to remaining dirty liquid which was the titrated with 0.025M thiosulphate. The result was recorded in mg/L. Equation 2.2 was used to compute the values of this parameter.

$$For\ 200cm3\ used, 1cm3\ thiosulphate = \frac{1mg}{l} DO$$
……………………………….…….2.2

2.2.5 Determination of biochemical oxygen demand (BOD)

Exactly 200cm^3 of water sample was poured in the bottle, 1cm^3 of $MnSO_4$ and 1cm^3 of alkali-iodide-azide solution were added from the pippete. The bottle was sealed and incubated in the dark at 20oc for 5 days. After which the mixture was removed from the dark and the clear liquid was decanted. 2cm^3 of conc. H_3PO_4 was added to the dirt liquid and titrated with 0.025M thiosulphate and the reading was recorded. Equation 2.3 was used to compute the values of this parameter.

$$BOD = the\ difference\ the\ two\ DO\ levels\ determined$$
…………………………………………….... 2.3

2.2.6 Determination of heavy metals from water samples

2.2.6.1 Digestion procedure

Exactly 50cm^3 of the water sample was measured and poured into the beaker and 5cm^3 of concentrated nitric acid was added. The mixture was heated on a hot plate until the volume reduced to 20cm^3, the mixture was allowed to cool and filtered with a filter paper. The sample was transferred to 50cm^3 bottle and diluted with distilled water; the digested solution of the water samples was taken for AAS analysis.

3.0 RESULTS

Table 3.1 and 3.2 shows the result of physiochemical analysis and heavy metals concentration in water samples.

Table: 3.1 the physiochemical parameters.

SAMPLES	A	B	W.H.O
pH	6.20	6.40	6.5-8.5
Turbidity (NTU)	0.011	0.308	5
Conductivity ($\mu s/cm$)	90	53	1000
T.D.S (mg/L)	12	3	1000
D.O (mg/L)	4.2	3.9	14
B.O.D (mg/L)	17.7	18.2	

Note: Sample A is the water from mining area, while sample B is well water the town.

Table: 3.2 Heavy metals composition of water samples (mg/L)

SAMPEL	A	B	W.H.O
Chromium (mg/L)	2.005	1.331	0.050
Lead (mg/L)	7.6	N D	0.010
Zinc (mg/L)	4.945	1.159	
Cadmium (mg/L)	N D	N D	0.003
Nickel (mg/L)	0.67	0.67	0.0
Copper (mg/L)	0.102	0.102	

4.0 DISCUSSION

4.1 Physiochemical parameters

4.1.1 pH

The result obtained showed that the pH values of water samples were found within the limit prescribed by WHO, and also the sample obtained from the mining area i.e sample A is more acidic compared to sample B. the values are 6.20 and 6.40 and that of W.H.O is 6.50-8.50.

4.1.2 Conductivity

The result obtained from Table 3.1 showed that the values were found within the acceptable limit set by WHO. The values are 90 and 53 and that of W.H.O is 1000$\mu s/cm$

4.1.3Turbidity

The results obtained from the table 3.1 shows that all the values 0.011 and 0.308 are found within the permissible limit of 5NTU set by WHO.

4.1.4Total dissolved solid

Total dissolved solids indicate the salinity behavior of groundwater. Water containing more than 1000mg/L of TDS is not considered desirable for drinking. The results obtain from Table 3.1 shows that the two samples values 12 and 3 are found within the prescribed limit 1000mg/L set by WHO.

4.1.5Dissolved oxygen

The result obtained from the analysis shows that all the values 4.2 and 3.9 are within the W.H.O maximum permissible limits 14mg/L.

4.1.6Heavy metals

The result obtained from this analysis were summarized in Table 3.2, the results shows that the values of chromium in sample A and B are 2.005 and 1.331 which is found to be above the W.H.O maximum permissible limit of 0.050mg/L. For lead (Pb) the results show from sample A is 7.6 and sample B is not detected which sample A is found to be above the maximum permissible limits set by W.H.O 0.010mg/L.High lead concentration may be attributed to the mineral processing activities or vehicular movement around the area, or both. Lead causes heavy metal poisoning; this results into the death of over 300 children, in the area under investigation, hence the water sample is not safe for use (The Guardian, 2017).

Zinc (Zn), concentration was found to be 4.945 and 1.159mg/L, for sample A and B respectively. The two results are found to be above the W.H.O maximum permissible limit of 1.01mg/L. Zinc is an essential element in human diet and it is required to maintain the functioning of the immune system. It is also a natural constituent of soils interrestrial ecosystem and it is taken up actively by roots (Adedekun *et al*., 2016).

Cadmium in sample A and B were not detected. For Nickel from the above result shows that both sample A and B has 0.67 that is found to be above the W.H.O maximum permissible limit of 0.05mg/L. High amount of cadmium in the body may result into kidney disorder and other body organs.

For copper, the result from Sample A and B shows to 0.102 that is found to be above the W.H.O maximum permissible limit of 0.07mg/L. This may be also due to local and illegal mining taking place very close to the village. Copper is important in the body as forms part of metaloprotein and also enzymes. But it presents in excessive amount result into aneamia, diabetes and some dysfunction of body organs(Adedekun et al., 2016).

5.0 CONCLUSION

The physiochemical parameters obtained from the samples were: pH, Turbidity, Conductivity, Dissolved oxygen and Biochemical oxygen demand, and their values were found to be within allowed limits set by W.H.O. for the concentration of heavy metals Cr, Pb, Zn, Cd, Ni, Cu all their values were found to be above the maximum permissible limit set by WHO except for Cadmium (Cd) in sample A while Lead (Pb) and Cadmium (Cd) in sample B. Finally, due to the high concentration of these heavy metals detected in the samples which may be related to local and illegal mining taking place close to the village, the water is not safe for drinking.

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