EFFECTS OF GOLD PROCESSING ACTIVITIES IN CHANCHAGA AREA OF NIGER STATE ON THE CHARACTERISTICS OF RECEIVING WATER BODIES

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ABSTRACT

Legal gold processing activities involving the crushing of rocks or sediments invariably leads to generation of tailings that may release some contaminants into the environment. Thus, the aim of this work was to determine the effect of legal gold processing activities in Chanchaga Area, Minna, Niger State on the receiving water bodies. To achieve this, four water samples were collected from the surrounding river called River Chanchaga (upper and lower), a borehole and a well in addition to the tailing effluent from the processing area. The samples were analysed for the presence of the following chemical parameters: Copper, Chromium, Lead, Zinc, Biological Oxygen Demand, Chemical Oxygen Demand, Potassium, Sodium and Calcium. The results obtained show that concentration of the heavy metals in the water samples analysed ranged from 0.00-0.03 mg/l for Cu, 0.40-0.59 mg/l for Cr and 0.63-1.65 mg/l for Zn while Pb was only detected in one sample (L_R) at a concentration of 0.01 mg/l. Also, BOD and COD of the water samples studied ranged from 4.0-8.2 mg/l and 5.0-10.6 mg/l respectively while K, Na and Ca concentrations were found to be in the range of 0.1-0.28 mg/l, 0.02-1.04 mg/l and 1.3-14.3 mg/l respectively. Thus, comparison of these results with that obtained for the tailing effluent and controlled to the conclusion that the heavy metals considered are released into the environment which subsequently get into the water bodies as a result of the gold processing activities, while K, Na and Ca were also noted to be released into the environment but are significantly retained or absorbed by the soil; hence their relative presence in the surrounding water as a result of mobility through the soil was not noticed. It could also be concluded that the legal gold processing activities have little or no effect on the BOD and COD of the receiving water bodies as compared to the standard.

Keywords: Gold processing, heavy metals, water, contamination
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INTRODUCTION

Nowadays, human activities greatly involve exploitation of the environment for wealth creation; some of these activities result in environmental pollution either directly or indirectly. Mining and mineral processing activity is one of such activities which contribute to the national wealth due to the major roles the solid minerals such as gold, diamond, copper, zinc, iron ore and lead play in industrial and human life. In Nigeria, mining is not an organized major source of revenue as government has shown little or no interest in the sector after the Second World War due to the discovery of crude oil [1]. Despite wealth creation to the nation, mining and mineral processing also poses danger to the land, fauna, flora and water in the environment in which it operates, especially the generation of great amount of solid waste such as rock waste and tailings which may be transported to the water bodies by erosion [2, 3]. Abandoned mines and mineral processing are known to disperse heavy metals to the soil and water, although their major effects are local but heavy metal distribution can be regional and even global [4].

Gold processing activities in Chanchaga involves the crushing of rocks and sediment by which separation process are done using water and the effluent left to flow freely to the ground, sink into the soil and flow into the adjourning flowing river in the region. These activities release heavy metals to the soil which are subsequently transported to the receiving water bodies thereby changing its physicochemical characteristics and making the heavy metals available for uptake by plants and animals [5]. Therefore, this research is aimed at accessing the effects of gold processing activities in Chanchaga area of Niger State on the chemical characteristics of the receiving water bodies around the processing site.

MATERIALS AND METHODS

Study site

The gold processing site is located in Chanchaga, Chanchaga Local Government Area of Niger state. It is located on Latitude 9.5333° and Longitude 6.5833°, and it is 21 km from Paiko and 20.9 km from Tungan in Niger state. The area, just like many other places in Niger state has mean annual rainfall of 1334 mm starting from April and lasting till October.

Materials

The materials used were water samples collected from around the processing site. The major chemicals used were hydrochloric acid and nitric acid, which are of analytical grades.

Sample collection/preparation

Water samples were collected from a hand-dug well and a borehole around the gold processing site, and also from upper and lower parts of River Chanchaga adjacent to the processing site. The samples collected from the Well, Borehole, Upper River and Lower River sections were labelled W_L, B_h, U_R and L_R respectively. In addition, tailing effluent was also collected from the site which was labelled as Slurry while clean water that is free of any form of contamination was also obtained for this study and labelled as Control. The water samples collected were kept in clean plastic bottles and stored in a refrigerator for subsequent digestion using HCl and HNO_3 [6].

Determination of sample chemical parameters

Concentration of the heavy metals, Lead (Pb), Copper (Cu), Chromium (Cr) and Zinc (Zn) were analyzed using Atomic Absorption Spectrophotometer. Similarly, Biochemical Oxygen Demand (BOD) was determined by Azide modification of the Winker method and Chemical Oxygen Demand (COD) was determined by refluxing.Also, Potassium (K), Sodium (Na) and Calcium (Ca) concentration was determined using flame photometer and all analyses were based on Standard Methods for the Examination of Water and Wastewater [7].

RESULTS AND DISCUSSION

Results obtained on analysis of heavy metals concentration in the water samples are as presented in the Table1. It was observed that the concentrations of the heavy metals in the water samples analysed ranged from 0.00-0.03 mg/l for Cu, 0.40-0.59 mg/l for Cr and 0.63-1.65 mg/l for Zn while Pb was only detected in one sample (L_R) at a concentration of 0.01 mg/l. Thus, highest Cu concentration of 0.03 mg/l was recorded for L_R and U_R as 0.01 mg/l was noted for B_h, while none was found in W_L. It was also observed that concentration of Cu in L_R and U_R water samples was higher than that of the Control with concentration of 0.01 mg/l but lower than that of the Slurry with concentration of 3.83 mg/l and this indicates that the gold processing activities in the area has effect on the receiving water body. For Cr, it was also observed that L_R recorded the highest concentration of 0.59 mg/l and this was followed by B_h with concentration of 0.54 mg/l, then U_R with concentration of 0.48 mg/l and lastly W_L with concentration of 0.4 mg/l, while Cr concentration in slurry and control were found to be 1.92 and 0.00 mg/l respectively.

Among the four samples studied, Pb was only detected in L_R at a concentration of 0.01 mg/l as against 1.83 mg/l in the slurry and nil in the Control. Also for Zn, concentration of 4.95 and 0.42 mg/l was noted for Slurry and Control respectively while for the water sample considered, highest concentration of 1.35 mg/l was recorded for W_L. This was followed by U_R and B_h with concentration of 0.93 and 0.92 mg/l respectively. The least concentration of 0.63 mg/l was obtained for L_R. This study, therefore demonstrated that heavy metals are released into the environment which subsequently get into the water bodies as evident on Table 1 which shows that the concentration of the heavy metals in all the water sample were higher than that of the control but lower than that of the slurry.

In addition, comparing the concentration of the heavy metals recorded with that of the WHO recommended limit for drinking water quality (1.0 mg/l for Cu, 0.05mg/l for Cr, 0.01 for Pb and 5.0 mg/l for Zn) as reported by Ibrahim *et al*. [6]; Olaniyan *et al*. [8], indicated that the concentration of all the heavy metals in the slurry are above the WHO limit while that of the Control are below the WHO limit. Further comparison also revealed that the concentration of Cr in all the water samples was noted to be above the WHO limit implying Cr contamination of the water samples, while concentration of Cu, Pb and Zn observed in all the water samples are below the WHO limit. Though results from this study suggest that continuous gold processing activities in the area could lead to contamination of the water bodies with Cu, Pb and Zn.

Table 1: Heavy metal distribution in water sample

Samples	Distance (m)	Cu (mg/l)	Cr (mg/l)	Pb (mg/l)	Zn (mg/l)
Slurry	-	3.83	1.92	1.83	4.95
L_R	20	0.03	0.59	0.01	0.63
U_R	30	0.03	0.48	0.00	0.93
B_h	500	0.01	0.54	0.00	0.92
W_L	200	0.00	0.40	0.00	1.35
Control		0.01	0.00	0.00	0.42
WHO (1971)		1.00	0.05	0.01	5.00

Table 2 shows that the BOD and COD of the water samples studied ranged from 4.0-8.2 mg/l and 5.0-10.6 mg/l respectively. While the BOD and COD recorded for the slurry is 0.01 mg/l and that of the control sample is 4.7 mg/l and 5.3 mg/l respectively. Akan *et al*. [9]; Kaur *et al*. [10] described high BOD level as an indication of low availability of oxygen for microbial activities such as the decomposition of organic matter, and high COD level as an indication of toxicity and low oxygen availability to chemically oxidize the biologically resistant organic substances to inorganic components. Thus, the higher BOD and COD observed in the four samples as compared to that of the Slurry could be attributed to reduced DO resulting from microbial activities as the slurry is being discharged into the environment. This implies that the gold

processing activities have little or no effect on the BOD and COD of the water sample studied. However, the BOD and COD of the water samples are below WHO limit of 6 mg/l and 10 mg/l respectively for drinking water quality as reported by Olaniyan *et al*. [8], except for W_L which recorded BOD and COD higher than the WHO limit.

Also, K and Na concentration in the water samples studied were found to be in the range of 0.1-0.28 mg/l and 0.02-1.04 mg/l respectively. These values are lower than the recorded values for the Slurry (8.2 and 10.46 mg/l for K and Na) and Control (1.31 and 1.52 mg/l for K and Na) respectively. Similarly, the concentration of Ca in the water samples was found to be 1.30, 1.97, 4.31 and 14.3 mg/l for L_R, U_R, W_L and B_h respectively as against 47.2 and 0.7 mg/l for Slurry and Control respectively. Therefore, the wide differential in concentration between the water samples and slurry could mean that these parameters are significantly retained or absorbed by the soil; hence their relative presence in the surrounding water as a result of mobility through the soil is very unlikely. The concentration of K, Na and Ca were found to be within the WHO limit as reported by Olaniyan *et al*. [8].

Table 2: Water samples characterisation

Sample	Distance (m)	BOD (mg/l)	COD (mg/l)	DO (mg/l)	K (mg/l)	Na (mg/l)	Ca (mg/l)
Slurry	-	0.01	0.01	8.60	8.20	10.46	47.2
L_R	6.0	5.00	5.80	5.00	0.10	0.02	1.30
U_R	10.0	5.00	5.00	5.02	0.12	0.02	1.97
B_h	500	4.00	4.70	4.02	0.06	0.73	14.30
W_L	200	8.20	10.60	4.85	0.28	1.04	4.31
Control		4.70	5.30	5.20	1.31	1.52	0.70
WHO (1971)		6.00	10.00	-	15.00	200	200

CONCLUSION

The outcome of this study has led to the conclusion that the heavy metals considered are released into the environment which subsequently get into the water bodies as a result of the gold processing activities. Though with the exception of Cr, concentration of the other heavy metals observed in all the water samples are below the WHO limit but continuous gold processing activities in the area could lead to bioaccumulation and subsequent contamination of the water bodies with these heavy metals. It could also be concluded that the gold processing activities have little or no effect on the BOD and COD of the receiving water bodies. In addition, K, Na and Ca were noted to be released into the environment as a result of the gold processing activities but are significantly retained or absorbed by the soil; hence their relative presence in the surrounding water as a result of mobility through the soil was not noticed.

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