

IMPACT OF ARTISANAL GOLD MINING ON HEAVY METAL CONCENTRATIONS IN SOIL AND WATER IN SABON EREGI COMMUNITY, NIGER STATE

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ABSTRACT

This study was carried out to determine the concentrations of selected heavy metals in stream water, borehole water and soil in Sabon Eregi mining site of Niger State. Samples were collected from three different points, before, within and after the mining sites and a control sample collected some distance away from the mining site, physicochemical properties of the water and soil samples were determined using standard methods. Heavy metals analysis of the water and soil samples was carried out using Atomic Absorption Spectrophotometry after acid digestion. The result of the heavy metal concentrations in mgdm^{-3} for stream and borehole water were: (0.10 - 0.35 and 0.42 - 0.48) for Mn, (BDL - 0.01 and BDL - 0.01) for Cd, (0.08 - 0.16 and 0.07 - 0.09) for Zn, (0.16 - 0.29 and 0.06 - 0.07) for Pb and (0.01 - 0.03 and BDL - 0.01) for Ni, while heavy metal concentrations in soil samples in mg/kg were (55.2 - 82.7) for Mn, (BDL - 0.28) for Cd, (25.4 - 53.5) for Zn, (37.7 - 34.2) for Pb and (6.35 - 7.22) for Ni respectively. Generally, the heavy metal concentrations in soil, stream and borehole water in the area were lower than the permissible limits. Thus, Sabon Eregi is still safe for the inhabitants despite the illegal mining activities going on in the area, but continuous monitoring of the area is recommended.

Keywords: Concentrations; Mining; Heavy metals; Soil; Water; Spectrophotometer

INTRODUCTION

The interest in the environmental levels of heavy metals is a global concern because of the potential problems of these elements to human health, animals and plants when they exist at high concentration [1; 2; 3]. Man's quest to satisfy his needs and aspirations for better living conditions through resource exploitation, like mineral mining has resulted to the distortion of the natural equilibrium through the release of toxic heavy metals to the environment [4, 5, 6]. Negative impacts of artisanal gold mining activities on water qualities, soil and the environment have been reported by several workers [7; 8; 9; 10; 11;]. Despite these negative challenges illegal gold mining activities still persist in most part of Niger State. There is therefore, the need to assess the concentration of heavy metals in soil and water within Sabon Eregi gold mining site to ascertain if they are within the limits that would not be injurious to the health of the inhabitants of that community.

MATERIALS AND METHODS

The soil and water samples were collected from before, within and after the mining site. The soil sample was pretreated and 1.0g of it was digested according to the method reported by Adelekan and Abegunde, [12] using mixture of 10:2:1 concentrated acids (HNO_3 , HClO_4 and HCl). Digestion of water samples was carried out according the method reported by Eletta[13] with some modifications. The digested samples were analysed using AAS (AA249FF Varian Model).

RESULTS AND DISCUSSION

The Mean±SD concentrations of heavy metals in stream water samples obtained from the study (Table 1) ranged from 0.10±0.01 mgdm⁻³ to 0.35±0.14 mgdm⁻³ Mn in the downstream and mining site respectively. Cd has a mean value ranging from BDL to 0.01±0.00 mgdm⁻³, Pb mean concentration ranged from 0.16±0.01 mgdm⁻³ to 0.29±0.01 mgdm⁻³ (upstream) and mining site respectively, Zn a mean value ranging from 0.08±0.01 mgdm⁻³ (upstream) and 0.18±0.02 mgdm⁻³ (mining site). The values of some of these results fell within the range reported by other workers of 0.036 to 2.24 mgdm⁻³ Mn [11,], 0.001 to 1.17 mgdm⁻³ Cd [14], 0.005 to 3.345 mgdm⁻³ Zn [8] in surface water around mining sites and above WHO recommended permissible limit [15]. According to Galadima and Garba, higher Pb concentrations have been associated with gold mining [16], thus, accounting for the high concentration of Pb obtained in present study. The obtained mean Ni concentrations of 0.01±0.01 mgdm⁻³ and 0.03±0.01 mgdm⁻³ was obtained from the water sample from the upstream and mining site respectively which is lower and higher than the permissible limit set by WHO of 0.02 mgdm⁻³ [15]. The slight increase however, may be due to anthropogenic input from mining activities on-going in the area.

Table 1: Heavy metal concentrations (mg/dm³) in stream water from SabonEregi mining Site

Samples	Mn	Cd	Zn	Pb	Ni
Upstream	0.16±0.03 ^c	BDL	0.08±0.01 ^b	0.16±0.01 ^c	0.01±0.00 ^c
Mining site	0.35±0.14 ^a	0.01±0.00 ^a	0.16±0.02 ^a	0.29±0.09 ^a	0.03±0.00 ^a
Downstream	0.10±0.01 ^b	BDL	0.11±0.01 ^{ab}	0.21±0.16 ^c	0.02±0.00 ^d
Control	0.16±0.02 ^c	BDL	0.07±0.01 ^b	0.01±0.08 ^b	0.01±0.01 ^b
WHO (Drinking Water 2008)	0.04	0.003	5.00	0.01	0.02

Values are Means± SD of triplicate determinations. Values with same superscripts in the same column are not significantly different at 95% confidence level while values whose superscripts differ in the same column are significantly different at 95% confidence level. The heavy metals content in borehole water from the study area (Table 2) ranged from 0.42±0.05 to 0.44±0.02 mgdm⁻³ Mn at the downstream and mining site, BDL (downstream) to 0.01±0.00 mgdm⁻³ Cd (mining site), 0.06±0.00^a to 0.07±0.01 mgdm⁻³ Pb, and BDL to 0.01±0.00 mgdm⁻³ Ni respectively. Some of these values are however, higher than the range reported by other worker [4] while they are within same range as reported by other worker [14], while other works reported [17,18] higher metals contamination level in underground water around mining sites.

Table 2: Heavy metal concentrations (mg/dm³) in Borehole water from SabonEregi mining Site

Samples	Mn	Cd	Zn	Pb	Ni
Upstream	0.48±0.01 ^a	BDL	0.08±0.00 ^a	0.06±0.00 ^a	BDL
Mining site	0.44±0.02 ^a	0.01±0.00 ^a	0.09±0.01 ^a	0.07±0.01 ^a	0.01±0.00 ^a
Downstream	0.42±0.05 ^a	BDL	0.07±0.03 ^a	0.07±0.01 ^a	BDL
Control	0.33±0.01 ^b	BDL	0.03±0.01 ^b	BDL	BDL
WHO (Drinking Water 2008)	0.04	0.003	5.00	0.01	0.02

Values are Means± SD of triplicate determinations. Values with same superscripts in the same column are not significantly different at 95% confidence level while values whose superscripts differ in the same column are significantly different at 95% confidence level.

From Table 3, the concentrations of heavy metals in the soil around the mining site ranged from 55.2 ± 19.1 mg/kg Mn in the downstream to 82.7 ± 5.66 mg/kg in the upstream, 34.1 ± 1.06 mg/kg to 37.7 ± 1.27 mg/kg Pb, BDL to 0.33 ± 0.03 mg/kg Cd, 25.4 ± 0.68 mg/kg to 53.5 ± 0.82 mg/kg Zn, 6.35 ± 0.04 mg/kg to 7.22 ± 0.25 mg/kg Ni at the mining site and downstream respectively. With the mining sites having higher concentration of lead compared to other sites. The results generally, are not so much in agreement with that reported by other workers in soils around mining sites. While higher metal concentrations were reported by some workers [19,20] in soils around mining sites, others [21,22] reported lower metal concentrations. These variations can be attributed to natural or anthropogenic activities. General, the concentrations of most metals analysed in the soil around the study area were all lower than the permissible limit for soil as recommended by USEPA [23].

Table 3. Heavy metal concentrations (mg/kg) in soil around SabonEregi Mining Site

Samples	Mn	Cd	Zn	Pb	Ni
Upstream	82.7 ± 5.66^b	BDL	25.4 ± 0.68^b	37.34 ± 0.92^a	7.02 ± 0.27^{ab}
Mining site	63.9 ± 13.03^a	0.28 ± 0.26^a	43.2 ± 9.57^a	37.7 ± 1.27^a	6.35 ± 0.04^{ab}
Downstream	55.2 ± 19.11^b	0.33 ± 0.03^a	53.5 ± 0.82^b	34.1 ± 1.06^a	7.22 ± 0.25^a
Control	64.7 ± 0.59^b	BDL	25.7 ± 0.82^b	33.6 ± 0.38^a	5.30 ± 0.21^b
USEPA (2010)	80.0	3.00	200	200	-

Values are Means \pm SD of triplicate determinations. Values with same superscripts in the same column are not significantly different at 95% confidence level while values whose superscripts differ in the same column are significantly different at 95% confidence level.

CONCLUSION

The result of this study had revealed the presence and levels of the selected heavy metals in water and soil samples from Sabon Eregi mining site of Niger State. The lower concentrations at the control sites compared with the study areas could be attributed to the mining activities at the site. However, most of the values obtained from the present study were generally lower than the recommended standards. This implies that Sabon Eregi mining site is still safe for the inhabitants, despite the illegal mining activity on-going in the area. It is recommended that Sabon Eregi mining site of Niger State be put under constant monitoring and the water sources, be analysed regularly in order to avoid heavy metal accumulation.

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