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Research Article

INVESTIGATING WATER CONTAMINATION BY LITHIUM MINING ACTIVITY IN ANGWA-KEDE, KOKONA LGA, NASARAWA STATE, NIGERIA

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ABSTRACT

Lithium mining in Nigeria poses lots of concern due to the uncontrolled mining practices used at different mining site as seen in various states where lithium ore is mined. Due to this, water samples were obtained from the host community and lithium mining pits in Angwa-Kede, Kokona LGA, Nasarawa State, Nigeria to check the level of lithium contamination in the water samples. The water samples were taken to the laboratory and analyzed using flame test analysis. Water sample results from the host community revealed that the lithium concentration ranges from 0.0093 to 0.0325 ppm Li which is higher than the standard value of 0.01 ppm Li thus indicating water toxicity while water samples from mining site ranges from 0.152 to 0.788 ppm Li. The mining risk factor (R_f) values for water quality at the mining site were found to be 0.012, 0.02, 0.034, 0.065, 0.154 which are quite low and this can be attributed to constant dewatering process at the mining site while the mining R_f values for water samples from host community were found to be 1.098 (River: Moderately high) and 0.285 (Borehole: Low), respectively. In conclusion, the flame test analysis result for all the water samples from the host community (River and Bore Hole) reveals the presence of lithium at concentrations that appear to be detrimental to human health. Accumulative amount of such lithium concentration in human body/blood could result to bipolar disease hence the need for water treatment and a more controlled mining practice.

Keywords: Lithium mining, Water quality, Water contamination, Mitigation.

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INTRODUCTION

Lithium extends its influence into the pharmaceutical sector, serving as a compound in mood-stabilizing drugs. Despite its role in pharmaceuticals and occasional use in the manufacture of methamphetamine, only a modest 2% of Lithium is allocated to the pharmaceutical industry. Furthermore, lithium compounds contribute to viscosity enhancement in oils and fats. Higher concentrations of lithium can pose toxicity risks to both humans and plants and given its diverse applications, there is a growing emphasis on studying lithium mobility within soil-plant-human systems, alongside its biological activity. This multifaceted investigation aims to comprehend the environmental implications and impact of lithium across different domains, fostering a comprehensive understanding of its role and potential risks (Robinson *et al.*, 2018).

The minimum concentration of lithium in water, plant, and human blood is presented in Table 1 below.

Safe lithium concentration in drinking water

In Belitz *et al.* (2021) research, the health-based screening level (HBSL) for lithium in drinking water calculated by the United States Geological Survey (USGS) in collaboration with the environmental protection agency (EPA) is set at 10 mg/liter (μg/L) and also expressed as parts per billion. The HBSL is developed based on scientific research and is intended to assist in risk assessment and decision-making processes related to water quality. They serve as reference points for evaluating the potential health impacts of contaminants in drinking water, taking into account available toxicological data and exposure assessments.

The HBSL for lithium reflects the concentration at which potential health effects may occur based on current scientific understanding. It is important to note that this level is a guideline to aid in assessing the potential risk associated with lithium exposure through drinking water consumption. When evaluating lithium concentrations in groundwater, comparing measured levels against the HBSL can help identify situations where further investigation or management actions may be warranted. If lithium concentrations exceed the HBSL, it may indicate the need for additional monitoring, assessment of potential sources, or implementation of mitigation measures to ensure the safety of drinking water supplies.

More so, the HBSL for lithium provides valuable context for understanding the potential health implications of lithium contamination in drinking water and supports informed decision-making to protect public health (Belitz *et al.*, 2021).

Safe lithium concentration in human blood

Lithium toxicity, known as lithium overdose, occurs when an individual takes an excessive amount of lithium, which is commonly prescribed as a mood-stabilizing medication for conditions such as bipolar disorder and major depressive disorder. Lithium is highly effective in managing mood disorders, but it has a narrow therapeutic window, meaning that the difference between a therapeutic dose and a toxic dose is relatively small. The safe blood level of lithium typically falls within the range of 0.6–1.2 milliequivalents/liter (mEq/L). This range is carefully monitored and adjusted by healthcare providers to ensure that patients receive the therapeutic benefits of lithium while minimizing the risk of toxicity. Lithium toxicity can occur when the blood level of lithium exceeds 1.5 mEq/L or higher. At these elevated levels, lithium can cause a range of adverse effects to human (Natalie Silver, 2019).

METHODS

Obtained water samples from the host community and mining areas were taken to the laboratory for analysis. Flame test analysis was done to check traces and percentage concentration of lithium in the water samples. The coordinates for the various location where water samples were obtained are seen in Table 2 below.

RESULTS AND DISCUSSION

Tables 3 and 4 above present the results of lithium content analyzed in the water samples of the mining site and the host community. The result

Table 1: Minimum concentration of lithium in soil, water, plant, and human blood

S/No.	Different types	Safe lithium concentration level	Safe lithium concentration level (ppm)
1	Water	10 μg/L	0.01 ppm
2	Plant	5–10 mg/kg	5–10 ppm
3	Human blood	0.6–1.2 (mEq/L)	0.01374–0.02748 ppm
4	Agricultural soil	0–200 mg/kg	0–200 ppm

Source: Natalie Silver (2019); Babar and Mohsin (2016); Belitz *et al.* (2020)

Table 2: Locations with coordinates where water samples were obtained

Water sample coordinates				
Mining site			Host community	
S/N	Latitude (X)	Longitude (Y)	Samples	Location
1	N8°47' 9.6468"	E7°57'8.0172"	Sample 1	River
2	N8°47'10.14"	E7°57'0.9"	Sample 2	Bore hole
3	N8°47'10.27"	E7°57'1.87"		
4	N8°47'9.63"	E7°57'2.49"		

Table 3: Flame test analysis for water sources in host community to detect lithium content

S/N	Water source	Li content (ppm)	Remark
1	River	0.0093	Within acceptable range
2	Bore hole	0.0325	Toxic to human health

Table 4: Flame test analysis of water samples obtained from lithium mining site to detect lithium content

S/N	Water samples	Li content (ppm)	Remark
1	Water sample 1	0.0649	Toxic to human health
2	Water sample 2	0.152	Toxic to human health
3	Water sample 3	0.788	Toxic to human health
4	Water sample 4	0.483	Toxic to human health
5	Water sample 5	0.291	Toxic to human health

Table 5: Mining risk factor from flame test result of water samples from host community/remark

S/N	Water source	Li content (ppm)	Mining risk factor (*Rf=Ci/Cn*)	Remark for risk (0–1: Low; 1–10: Moderate; >10: High)
1	River	0.0093	1.098	Moderate
2	Bore hole	0.0325	0.285	Low

Table 6: Mining risk factor from flame test result of water samples from mining site/remark

S/N	Water samples	Li content (ppm)	Mining risk factor (*Rf=Ci/Cn*)	Remark of risk (0–1: Low; 1–10: Moderate; >10: High)
1	Water sample 1	0.0649	0.154	Low
2	Water sample 2	0.152	0.065	Low
3	Water sample 3	0.788	0.012	Low
4	Water sample 4	0.483	0.020	Low
5	Water sample 5	0.291	0.034	Low

in Tables 3 and 4 reveals the presence of lithium in both water samples. Therefore, there are high tendency of lithium content to be found in plants within the environment and such can be transferred into food chain through various plants consumed by man. However, USGS and EPA stipulated that the minimal concentration of lithium in drinking water is 0.01 ppm, and above the limit, water can be considered to be unsafe for consumption. Comparing the results of the lithium contents in Tables 3 and 4, respectively, to the stipulated 0.01 ppm as safe standard for drinking water, it can be observed that the concentration of lithium in water samples 1, 2, 3, 4, and 5 in Table 4 are higher than the 0.01 ppm when compared. This trend could be attributed to the uncontrolled mining activity within the study area joined with weathering and leaching of lithium ore into water sources of the host community and mining site. However, the lithium content (0.0093 ppm) detected in the river water as seen in Table 3 is slightly lower than 0.01 ppm (safe standard) which can be attributed to the dynamics of the steady flow of the river and its dilution that is based on the inflow of fresh water sources into the river. The result from the borehole water sourced revealed a high concentration of lithium (0.0325 ppm) when compared to 0.01 ppm safe standard. This trend can be attributed to weathering and leaching that could have been triggered by uncontrolled mining activities within the vicinity of the mined environment. Usually, uncontrolled mining activities have been found to create seismic vibration that causes fragmentation of rocks leading to the creation of pores within the ore and hence exacerbating leaching, seeping, and dissolution of minerals associated with lithium host rock. The outcome of the trend can lead to high concentration of dissolved minerals and contamination of underground water like borehole hence the situation recorded for the borehole result in Table 3. Furthermore, the remarks for the lithium content for all the water samples analyzed from the mining site indicate that the water samples at the mining site are toxic and unfit for human consumption unless the water samples are treated.

Tables 5 and 6 present the mining R_f values for the mining activities in the host community. The mining R_f values of the water samples from the host community (river are moderately high with a factor value of 1.098 while that of the borehole is low with 0.285). This trend indicates that as time progresses, the mining activity will increase the risk of borehole contamination since there are possibilities of the river water infiltrating the soil through seismic cracks created by the uncontrolled mining and tectonic activities within ore deposit of the host community. However, the mining R_f values of the water samples from the mining site reveal low R_f values of <1 and this is an indication that the water samples at the mining site are quickly discharged to the surrounding during dewatering process and replaced by fresh ones after mining. More so, the variations in lithium concentrations of the water samples indicate that there is a gradual progressive increase of lithium in the water samples arrowing a potential threat to future contamination of the water samples by lithium.

CONCLUSION

Lithium mining activity as seen in Angwa-Kede community defiles lots of mining standards and this is seen in the presence of lithium concentration in water samples obtained from the host community. With this in view, various mining agencies, the Ministry of Mines and Steel Development, and other mining society needs to carry out more mining programs to sensitize various mining companies on the need to mine safely with the health of both workers and the community in mind. From the obtained results, proactive measures need to be put in place to avert futuristic doom in Angwa-Kede community which may be caused by lithium poisoning.

Recommendations/mitigations

i. Wastewater treatment should be carried out before discharging the treated water to the rivers and streams of the host community
ii. Clean water supply facilities should be provided for water distribution in host mining community
iii. Safe mining practice should be adopted in to replace the artisanal mining method

iv. Abandoned mining pits should be immediately re-clammed to avoid runoff from the mine pit.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

As approved by the Department of Metallurgical and Materials Engineering; Ahmadu Bello University, Nigeria for the purpose of "Academic Research" and "Addition to Knowledge."

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA AND MATERIALS

Not applicable.

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AUTHOR'S CONTRIBUTION

EEC was involved in the fieldwork, site visitation, collection of data, writing, and typing of the research while RAM and DT were research supervisors. All authors have read and approved the final manuscript.

COMPETING INTEREST

On behalf of all authors, the corresponding author states that there are no conflicts of interest.

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REFERENCES

Belitz, K., Cravotta, C.A., Lindsey, B.D., Toccalino, P.L., and Dubrovsky, N.M (2021): Lithium Concentration in old ground water and ground water in arid reagions: Science of the Total Environment, v. 767. https://doi.org/10.1016/j.scitotenv.2020.144691

Babar, S., & Mohsin, T. (2016). Lithium toxicity in plants: Reasons, mechanisms and remediation possibilities: A review. *Plant Physiology and Biochemistry*, *107*, 104-115.

Natalie Silver. (2019). *The Facts about Lithium Toxicity*. Available from: https://www.healthline.com/health/bipolar-disorder/long-term-effects-on-the-body [Last accessed on 2023 Sep 29].

Robinson, W.O., Steinkoenig, L.A., & Miller, C.F. (2018). *The Relation of Some of the Rare Elements in Soils and Plants*. U.S. Department of Agriculture Bull No 600. U.S. Government Printing Office, Washington, DC, p. 27.