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Assessment of heavy metals and health implications in borehole water of Shao in Moro LGA, Kwara State

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ABSTRACT

Problems of kidney, liver, hypertension and cancer diseases are common this day in some parts of Nigeria among adults which could be due to prolong drinking of water containing high concentrations of heavy metals such as Arsenic, Barium, Cadmium, Chromium, Copper, Lead, and Manganese. There is a need for creating awareness in the country about the health implications of prolong drinking of water with high concentrations of heavy metals which could cause some severe diseases to man. This study was conducted to determine the concentrations of some selected heavy metals in the borehole water of Shao in Moro Local Government Area, Kwara State, Nigeria. Water samples were collected in March, 2020 from 6 borehole locations at Shao and physic-chemical properties were analyzed using standard methods. The samples were collected in March during dry season to get the actual contribution of the geological nature of the area for the heavy metals. In March, there is little or no underground water pollution from agricultural wastes, pesticides, industrial wastes and percolation of contaminated runoff. The concentrations of Cadmium, Chromium, Copper, Lead, Manganese and Zinc in the samples were 0.003-0.016 (Standard Organisation of Nigeria – SON limit: 0.003), 0.012-0.012 (SON: 0.050), 0.005-0.030 (SON: 1.000), 0.058-0.058 (SON: 0.010), 0.002-0.024 (SON: 0.200), 0.013-0.098 mg/L (SON: 3.000mg/L), respectively. Concentrations of Arsenic and Mercury were not detected in all the 6 boreholes. The concentrations of Cadmium which is toxic to kidney were above the permissible limits of SON in 5 boreholes and Lead that could cause cancer and mental disorder among children were above the permissible limits of SON in one borehole. Borehole water with high concentration of heavy metals should be treated before consumption to prevent some deadly diseases that could affect man.

Keywords: Borehole water, heavy metals, underground water, water quality, water pollution

Introduction

Problems of kidney, liver, hypertension, cancer and some other related diseases are common this day in Nigeria to men and women especially the adults (WHO, 2011). Lead, Cadmium, Chromium and Nickel are cancer-disease causing heavy metals present in underground water (Adeyemi and Ojekunle, 2021). Standard Organisation of Nigeria (SON, 2007) for drinking water quality pointed out that some of the diseases caused by heavy metals are due to prolong drinking of water that have high concentrations of heavy metals such as Aluminum, Arsenic, Barium, Cadmium, Chromium, Copper, Lead, Manganese, Mercury and Nickel. Many people do not know the health implications of prolong drinking of water with high concentrations

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of the heavy metals that could cause some severe diseases to man. Heavy metals could be absorbed by plants, eaten by animals, consumed by man from drinking water and food or enter tissues by inhalation (Sawere and Ojeba, 2016).

There is a need for creating awareness in the country about the health implications of drinking water having high concentration of heavy metals for a long period of time. Groundwater (borehole water) is one of the major sources of water especially in the rural areas of Nigeria (Amori *et al*., 2013). Borehole water is normally free from pathogens that could cause diseases such as typhoid, cholera and other diseases to man but borehole water could have problem of high concentrations of heavy metals and other chemicals from the geological formation of the area and pollution by underground water flow (Yusuf *et al*., 2012). Adepoju-Bello and Alabi (2005) pointed out that heavy metals could cause serious health problems depending on the nature and quantity of the heavy metals consumed. Adeyemi *et al*. (2007) reported that groundwater quality is affected by the chemical composition of the media through which the water flows in underground to the aquifer. Olatunji *et al*. (2015) reported that the quality of groundwater depends on the quality of recharging water, atmospheric precipitation, in-land surface water and sub-surface geochemical processes.

Heavy metals are metallic elements with relatively high density and are toxic at concentrations above the permissible limits by Standard Organisation of Nigeria (SON, 2007) and World Health Organisation (WHO, 2011). Martnez and Motto (2000) reported that the solubility of heavy metals in groundwater depend on pH of the groundwater, available heavy metals and cation exchange capacity. Heavy metals are natural component of earth's crust that could dissolve in water by geological processes; it could be consumed in water and food (Obi and Georgy, 2011). Orosun *et al*. (2016) pointed out that mining and smelting activities are major causes of groundwater pollution by heavy metals which is hazardous to human health. Jerup (2003) pointed out that heavy metals could lead to damage of central nervous system, problems of kidney, liver, lung, progressive neurological disorder and could cause cancer. Health implications of some chemicals and heavy metals are presented in Table 1 to create awareness for people and to serve as guide for the quality of drinking water. The objective of this study was to determine the concentrations of selected heavy metals in the borehole water of Shao in Moro Local Government Area, Kwara State, Nigeria.

Table 1: Water quality standards and health implications of chemicals in drinking water

Heavy metal	SON (2007)	WHO (2008)	Health implication by SON (2007)
Aluminum (mg/L)	0.200	-	Potential Neuro-degenerative disorder
Arsenic (mg/L)	0.010	0.010	Cancer
Barium (mg/L)	0.700	0.700	Hypertension
Cadmium (mg/L)	0.003	0.003	Toxic to kidney
Chromium (mg/L)	0.050	0.050	Cancer
Copper (mg/L)	1.000	2.000	Gastrointestinal disorder
Cyanide (mg/L)	0.010	0.070	Very toxic to the thyroid and the nervous system
Lead (mg/L)	0.010	0.010	Cancer, interference with Vitamin D metabolism, affect mental development in infants, toxic the central and peripheral nervous systems
Manganese (mg/L)	0.200	0.400	Neurological disorder
Mercury (mg/L)	0.001	0.006	Affect kidney and central nervous system
Nickel (mg/L)	0.020	0.070	Possible carcinogenic
Zinc (mg/L)	3.000	-	None
Iron (mg/L)	0.300	-	None
Magnesium (mg/L)	0.200	-	Consumer acceptability
Sodium (mg/L)	200.0	-	None
Pesticides (mg/L)	0.010	-	Possibly carcinogenic
Fluoride (mg/L)	0.200	1.500	Fluorosis, bones and teeth morbidity (tooth decay)
Nitrate (mg/L)	50.00	50.00	Cyanosis and asphyxia (blue-baby syndrome) in infants under 3 months
Nitrite (mg/L)	0.200	3.000	Cyanosis and asphyxia (blue-baby syndrome) in infants under 3 months
Chloride (mg/L)	250.0	-	None
Hydrogen sulphide (mg/L)	0.050	-	None
Detergent (mg/L)	0.010	-	Possibly carcinogenic
Mineral oil (mg/L)	0.003	-	Possibly carcinogenic
Phenols (mg/L)	0.001	-	Possibly carcinogenic

SON = Standard Organisation of Nigeria
WHO = World Health Organisation

Materials and Methods

Location of the study

The water samples were collected at the town of Shao in Moro Local Government Area of Kwara State, Nigeria. Shao town is an ancient town about 5 km to the city of Ilorin. Shao is located on latitude 8°30¹N and longitude 4°35¹E, 340 m above the mean sea level and has about 1,300 mm annual rainfall (Ejieji and Adeniran, 2009). The six (6) boreholes assessed in this study were shown in Table 2.

Table 2: Locations and types of the boreholes assessed at Shao town

S/No	Borehole ID No	Location	Type of pump
1	BH1	Olohunsogo compound	Submerged
2	BH2	Isale Oja compound	Submerged
3	BH3	Oju Oja compound	Hand
4	BH4	Oke Sinniga compound	Submerged
5	BH5	Oroho Palace	Submerged
6	BH6	ICPC-NAVC Office	Hand

Collection of water samples from the 6 boreholes

Water samples were collected from the 6 functional boreholes where people normally fetch water for drinking and other domestic uses at Shao in Moro Local Government Area, Kwara State. The water samples were collected from the boreholes and put in a sterilized 500 ml plastic bottle and covered.

Determination of heavy metals from the water samples

The heavy metals that were determined from the water samples were Arsenic, Cadmium, Chromium, Copper, Lead, Manganese, Mercury and Zinc. The water was digested by adding 5 ml of concentrated nitric acid to 30 ml of the water sample using a glass serological pipette and filtered. A 15 ml of the acidified water content was transferred to a 250 ml Erlenmeyer flask. A 5 ml of 1:1 hydrochloric acid was then added and heated on a hot plate for 15 minutes at 95 °C for the brownish fumes to be expelled to show that the water sample had been digested (Bader, 2011). Arsenic, Cadmium, Chromium, Copper, Lead, Manganese, Mercury, Zinc were determined using the standard methods given by APHA (2005) and AOAC (2000). The pH of the water samples was determined using the pH meter (Model: 850048PHK by Sper Scientific Direct).

Results and Discussion

The mean concentrations of Arsenic, Cadmium, Chromium, Copper, Lead, Manganese, Mercury, Zinc and pH in the water samples from the 6 boreholes were presented in Table 3. From the 6 boreholes from which water were sampled at Shao, Arsenic and Mercury were not detected, which means that the concentrations of Arsenic and Mercury in the water were not detected or negligible. The concentrations of Cadmium were above the permissible limits of drinking water given by SON (2007) and WHO (2008) in 5 locations of the borehole at Shao except borehole at Oroho Palace which was denoted by BH5 as shown in Table 3. Cadmium is very toxic to kidney and could cause kidney disease after drinking the water for prolonged exposure. Yusuf and Sulaiman (2016) reported that borehole water from 6 different locations in Sango Ward of Ilorin, Kwara State which is about 6 km away from Shao had high concentrations of Cadmium that were above the permissible limit of SON (2007).

Chromium (Cr^{2+}) was not detected in water samples from 3 boreholes (Borehole at Oju Oja compound denoted by BH3, Oroho Palace denoted by BH5 and ICPC-NAVC Office with ID No BH6). Chromium was detected in the water samples from 3 boreholes (borehole at Olohunsogo compound with ID No BH1, borehole at Isale Oja compound with ID No BH2 and

borehole at Oke Sinniga compound with ID No BH4) but the concentrations were below the

permissible limit by SON (2007) and WHO (2008) as shown in Table 3. Mercury was not detected from the 6 boreholes. The concentrations of Copper and Manganese in 6 boreholes were below the permissible limit of SON (2007).

Lead (Pb^{2+}) was not detected in 5 locations of the borehole but the concentration of Lead at Oroho Palace (BH5) was 0.058 mg/L which was above the limit. This high concentration of Lead could cause cancer to man and could also affect mental development of infants (SON, 2007) as presented in Table 1. The high concentrations of some heavy metals like Cadmium and Lead could be due to underground water flow because pollution of underground water from industrial waste, agricultural waste, herbicides and insecticides. Adeyemi *et al*. (2007) agreed on this that the quality of groundwater is affected by the nature and characteristics of the media through which the water flows in the underground to the aquifer. The pH of the water samples were within the permissible limit of drinking water.

Table 3: Concentrations of the heavy metals in the 6 boreholes water samples

Heavy metal	BH1	BH2	BH3	BH4	BH5	BH6	SON 2007	WHO 2008
Arsenic (mg/L)	ND	ND	ND	ND	ND	ND	0.010	0.010
Cadmium (mg/L)	0.016	0.120	0.008	0.004	0.003	0.005	0.003	0.003
Chromium (mg/L)	0.012	0.012	ND	0.012	ND	ND	0.050	0.050
Copper (mg/L)	0.005	ND	0.015	0.015	0.015	0.030	1.000	2.000
Lead (mg/L)	ND	ND	ND	ND	0.058	ND	0.010	0.010
Manganese (mg/L)	0.006	0.010	0.017	0.024	0.002	0.009	0.200	0.400
Mercury (mg/L)	ND	ND	ND	ND	ND	ND	0.001	0.006
Zinc (mg/L)	0.045	0.023	0.098	0.013	0.025	0.028	3.000	-
pH	7.2	7.100	7.100	7.000	7.800	7.300	6.5-8.5	6.5-8.5

BH1 = Borehole at Olohunsogo compound, BH2 = Borehole at Isale Oja compound
BH3 = Borehole at Oju Oja compound, BH4 = Oke Sinniga compound
BH5 = Oroho Palace, BH6 = ICPC-NAVC Office, ND = Not Detected

Conclusion

Concentrations of some selected heavy metals in the 6 boreholes water of Shao in Moro Local Government Area, Kwara State, Nigeria were determined. Arsenic and Mercury were negligible in the borehole water and they were not detected in the 6 boreholes. Concentrations of Cadmium which is toxic to kidney were above the permissible limits in the 6 locations of the borehole. Lead was detected in only one borehole but it was above the permissible limit.

Recommendation

Water samples should be collected during the peak period of rainy season to determine the contribution of groundwater pollution due to runoff, seepage and industrial waste products. The borehole water where the Cadmium and Lead were above the permissible limit should be treated by passing it through the activated carbon to reduce the heavy metals concentration in the water.

Conflict of Interest

The research was funded by the authors and no fund was received from any organization or

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