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Assessment of Heavy Metals Content of Hand Dug Wells in Shasha Market, South Western, Nigeria

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ABSTRACT: The presence of heavy metals in potable water can cause serious health issues when consumed by humans. Hence, the objective of this paper is to assess the of heavy metals content of hand dug wells in Shasha market, Akure, South Western Nigeria were analyzed. The presence of five (5) heavy metals namely Zinc (Zn), Iron (Fe), Manganese (Mn), Cadmium (Cd) and Chromium (Cr) in the water samples were analyzed in the laboratory. Atomic Absorption Spectrometry was used in the heavy metal analysis. The Zn, Fe and Mn contents of the water samples fell within WHO standard for potable water. However, the study revealed Cd contamination in 100% of the water samples analyzed with a range of 0.005 mg/L to 0.013 mg/L as against the WHO maximum permissible limit of 0.003 mg/L for potable water. The results revealed that the concentrations of Cr in all the samples analyzed ranged between 0.021 and 0.10 mg/L with only 20% of the well water samples analyzed having values above the WHO Cr maximum permissible limit of 0.05 mg/L for potable water. Even though the Zn, Fe and Mn contents of the water samples fell within WHO standard for potable water, adequate treatment is required for all the well water samples before human consumption.

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A market is a place where people meet regularly in order to acquire and/or dispose-off locally produced goods as well as imported goods and services. It is simply a system that allows buyers and sellers to exchange goods and services. Commercial activities are the back-bone of different economies hence the existence of markets in any town or city cannot be over emphasized (Fakere and Fadamiro, 2012). Market systems are dynamic and hence require continuous modification and upgrading (Omotoye-Omisore *et al.*, 2016). Improper hygiene in markets has been a major source of concern in developing countries like Nigeria where little or no attention is paid to provision of proper refuse dumps and public toilets (Fakere and Fadamiro, 2012). Heavy metals are non-degradable and toxic, hence their presence in water is a source of global concern (Shafie *et al.*, 2014). Ojo and Adekunle (2016) evaluated the concentration of heavy metals in Harvested Rain Water in Aule area of Akure, South Western Nigeria. The results of the study indicated high contamination of the water samples as a result of heavy metals in concentration that exceed WHO permissible limits. The study recommended that caution be taken in the use of the water for domestic purposes and further suggested that treatment should be explored as a means of improving the quality of harvested rain water in the study area before human consumption.

The presence of heavy metals such as zinc, copper and cadmium in water increases the risk of entering the human body thereby causing serious health issues (Khan *et al.*, 2013; Guan *et al.*, 2014; Molahoseini, 2014; Olukanni *et al*, 2014; Chen *et al.*, 2016). Heavy metals are toxic, even at very low concentrations (Marcovecchio *et al.*, 2007). Increase of heavy metals within the body can lead to a decrease in the mental, psychological and physical health of the individual

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(Aziz *et al.*, 2005). For instance, excess amount of iron (more than 10 ppm) could cause coagulation of blood in blood vessels, rapid increase in pulse rate, drowsiness and hypertension (WHO, 2008). If the concentration of heavy metals found in water sample is high, then heavy metal pollution is said to occur (Tripathee *et al*., 2016; Kilunga *et al.,* 2017; Sun *et al.,* 2017). Heavy metals exist in water in colloidal, particulate and dissolved forms (Adepoju-Bello *et al*., 2009). Groundwater is a very important source of water usually extracted through wells and boreholes (Mendie, 2005). Groundwater contamination is regarded as one of the most significant environmental issues needing pressing attention (Nwankwo, 2013; WHO, 2011). Wells could be protected, unprotected or semi protected. A protected well is a large diameter hand dug well with a lining, a concrete cover and a mechanism to raise water (Ayantobo *et al.,* 2012). An un-protected well does not have any of the above features while a semi-protected well has only some of the listed features (Oluwasanya *et al*., 2011). Well water is disposed to contamination (MacDonald *et al.*, 2005), especially in areas where well are poorly or completely un-protected (Oluwasanya *et al*., 2011). This is particularly worrisome particularly in areas where well are poorly or totally un-protected (Oluwasanya *et al*., 2011). The method of abstraction of water from hand dug wells could introduce pollutants into these wells (Obeta and Mamah, 2017). Protecting well water is essential in order to sustain safe drinking water supplies (Olusiji, 2012). Heavy metals discharged by traffic, municipal wastes, and hazardous waste sites as well as from fertilizers for agricultural purposes can lead to steady rise in contamination of ground water (Igwilo *et al.,* 2006). For the protection of human health, guidelines for the presence of heavy metals in water have been set by different International Organizations including the World Health Organization (WHO) (Marcovecchio *et al.,* 2007). Hence, the objective of this paper is to assess the of heavy metals content of hand dug wells in Shasha market, South Western Nigeria.

MATERIALS AND METHODS

Study Area: The study was carried out in Shasha market located around the boundary of Akure North Local Government Area of Ondo State, South western, Nigeria. The local government shares boundary with Akure. Akure the capital city of Ondo State in the South Western part of Nigeria. It is about 370m above sea level and lies between Longitude 50 15' and 50 18' East of the Greenwich Meridian and Latitude 70 15' and 70 17' North of the Equator, it is located approximately 311km North East of Lagos. (Fakere and Fadamiro, 2012). Shasha market is situated northwest of Oba-Ile, close to the popular Benin Garage in Akure. Shasha Market is a very big raw food market in the Ondo State. It is majorly dominated by the Hausa-Fulani ethnic descent of Nigeria. Figure 1 shows the map of the study area. Four wells were extensively evaluated in this study. These wells were picked based on the fact that they were less than the recommended minimum horizontal safe distances of 30 m to onsite sanitation systems (Sphere Project, 2011). Table 1 shows the locations of the wells from which the water samples were collected while Table 2 shows the classification of the wells based on structure, mode of operation, depth and age.

Sampling Methods: In order to assess the quality of the well water in the study area, water samples were collected from hand dug wells in the study area whose distances to onsite sanitation systems were less than the recommended safe minimum horizontal distance. All hand dug wells from which water samples were collected were cased and have been in use for at least 3-5 years near the sanitation system. The water samples were collected in 500mL plastic bottles. Preservation of the collected water samples was done in order to preserve the integrity of the water samples. Sample preservation was done by making slurry of ice to cool the water samples at 4°C in order to minimize the potential of volatilization between sampling and analysis (APHA, 2005).

Preparation of Stock solution: Stock solutions were prepared by weighing out a specific amount of metal (salt) and transferred into a 100 ml volumetric flask. The metals were dissolved completely by adding deionized water (Greenberg *et al.*, 1992).

Preparation of Sample: The sample was collected in a clean polyethylene bottles. Polyethylene bottles were used in these analyses because glass bottles absorb metals and therefore will cause erroneousness to analysis. The water was filtered through a 0.45μm membrane filter as soon as possible after collection. The first 50 - 100 mL of sample was used to rinse the apparatus. The required sample volume was then collected. Acidification with (1+1) nitric acid to pH 2 or less was used to stabilize the metal content. No preservation was needed.

The sample was not filtered (Greenberg *et al.*, 1992; Hauser, 2002).

Calibration of Atomic Absorption Spectrometry (AAS): The characteristic concentration check value is the concentration of element (in mg/L) that will produce a signal of approximately 0.2 absorbance units under optimum conditions at the wavelength listed. Calibration of AAS was carried out by using an external calibration curve. The external calibration curve was prepared from solution of known concentrations of the sample element, which was also known as stock solution. High purity metal salts dissolved in high purity acids were used to make the stock solution. Working standards were diluted from the stock standard.

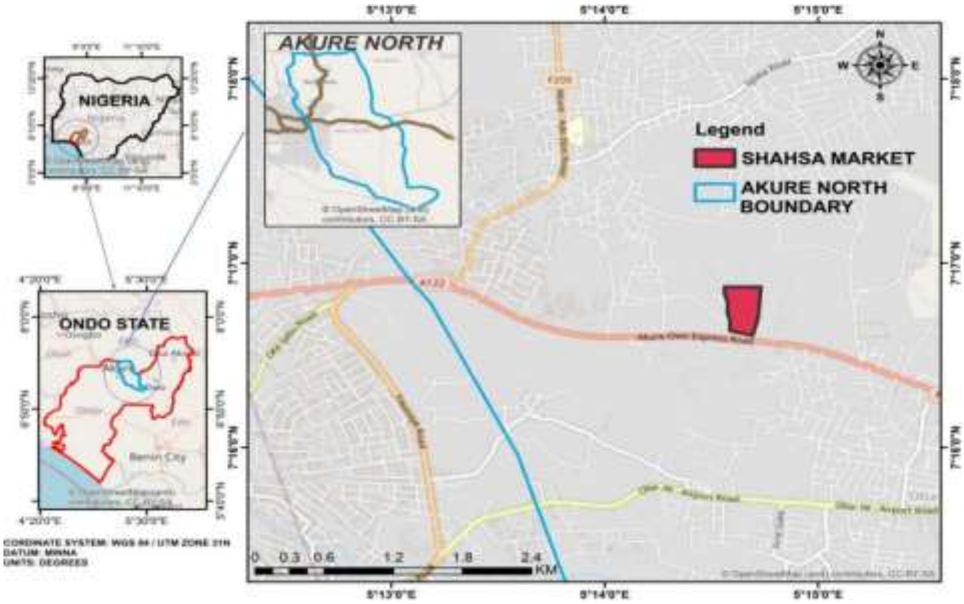

Fig 1: Map of the study area

Table 1: GPS location of the sample wells

Samples	*Latitude*	*Longitude*
A	7º 17' 13.22" N	5º 13' 54.27" E
B	7º 16' 38.57" N	5º 13' 54.27" E
C	7º 16' 39.68" N	5º 14' 34.36" E
D	7º 16' 41.36" N	5º 14' 32.66" E

Table 2: Well classifications based on structure, mode of operation, depth and age

Construction Pattern	**Sample A**	**Sample B**	**Sample C**	**Sample D**
Well Structure	Protected Well	Semi-Protected Well	Unprotected Well	Unprotected Well
Well Operation	Bucket and Rope (private)	Bucket and Rope (public)	Bucket and Rope (public)	Bucket and Rope (public)
Sanitation Type in close proximity	Pit Latrine	Waste Dump Site	Waste Dump Site	Waste Dump Site
Distance to sanitation (m)	14.3	19.2	16.7	12
Well depth (m)	12	10	15	14
Well Age (years)	5	10	12	12
Average No of Users	Less than 25	Greater than 50	Greater than 50	Greater than 50

RESULTS AND DISCUSSION

Zinc (Zn): The concentration of Zn had its minimum concentration as 0.862 mg/L and its maximum concentration as 1.213 mg/L in the well water samples analyzed while WHO Zn maximum permissible limit for potable water is 3 mg/L. The Zn content of all the well water samples fell within WHO acceptable standard as shown in Figure 2. *Iron (Fe):* The standard indicated by WHO for Fe in drinking water is 0.30 mg/L. The concentrations of Fe in all the analyzed water samples ranged from 0.240 to 0.30 mg/L. The results revealed that the Fe content of all the water samples analyzed were within the WHO standard for potable water as shown in Figure 3. Excess amount of Fe has been documented to cause coagulation of blood in blood vessels, drowsiness and hypertension (WHO, 2008). *Manganese (Mn):* Mn is one of the most abundant metals in the earth crust, it is an essential element for humans and other animals and occurs naturally in food and water sources. From the results obtained, it can be seen that the concentration of Mn for all the water sample ranged from 0.095 to 0.131 mg/L, therefore all sample had Mn content below the WHO maximum permissible limit of 0.4 mg/L as shown in Figure 4.

Chromium (Cr): The results revealed that the concentrations of Cr in all the samples analyzed ranged between 0.021 and 0.10 mg/L, while Sample B showed values above the WHO guideline of 0.05 mg/L as shown in Figure 5. Ojo (2022) also reported the presence of Cr in well water samples located in close proximity to septic tanks. The presence of Cr in Sample B may be due to the local geology of the study area (Orosun *et al*., 2016). According to Tseng *et al*. (2003), long term exposure to Cr can lead to skin irritation and also cause damage to liver, kidney and nerve tissues.

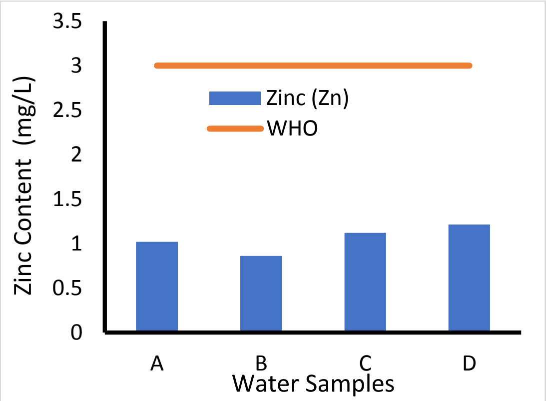

Fig 2: Zn content of the samples

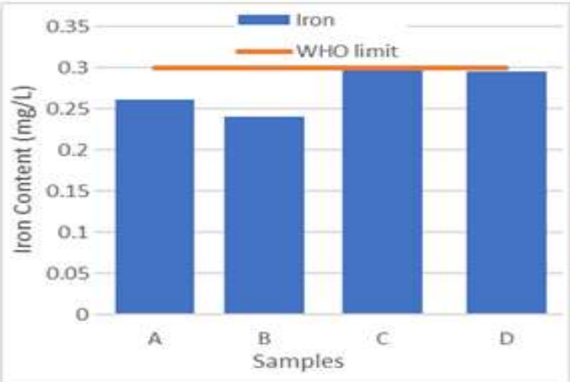

Fig 3: Fe content of the sample

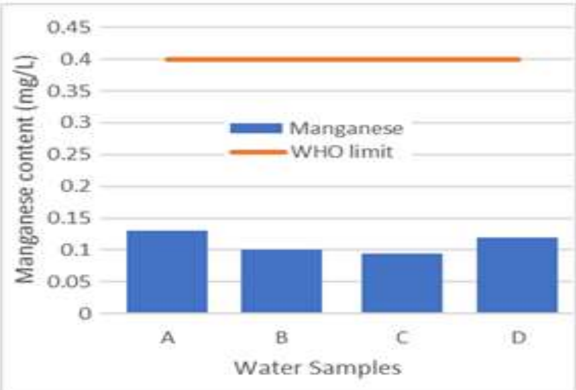

Fig 4: Mn content of the samples

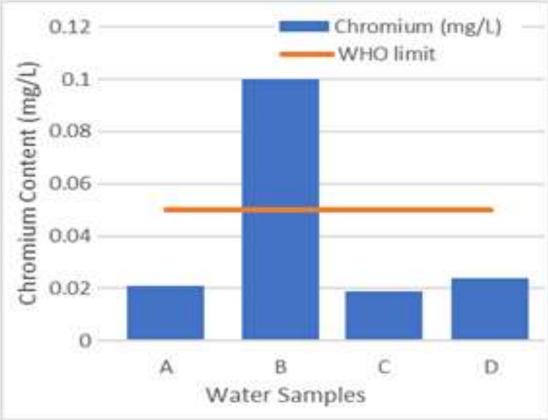

Fig 5: Cr content of the samples

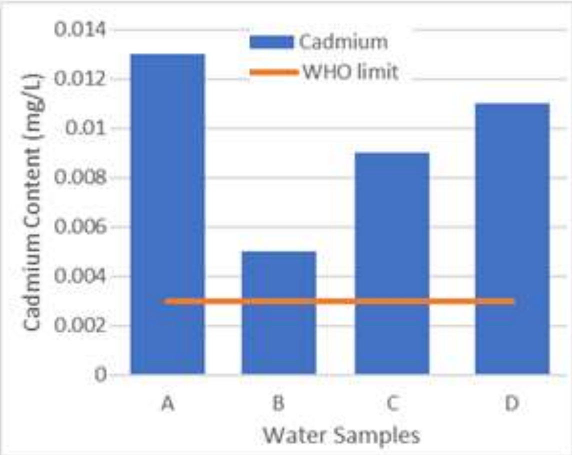

Fig 6: Cd content of the samples

Cadmium (Cd): The results revealed that Cd concentration in all sample ranged from 0.005 mg/L to 0.013 mg/L. All the samples did not fall within WHO permissible limit of 0.003 mg/L as shown in Figure 6. Cd occurs naturally in the environment. Additional releases of Cd to the environment occur from natural sources and from processes such as combustion of fossil fuel, incineration of municipal or industrial wastes, or land application of sewage sludge or fertilizer. Cd can cause severe damages to the lungs and respiratory irritation, while its ingestion in higher dose can cause stomach irritation resulting to vomiting and diarrhea. Prolonged exposure to Cd can also cause hypertension and kidney damage (Orosun *et al*., 2016).

Conclusion: The heavy metal content of wells in close proximity to indiscriminately sited sanitation facilities was analyzed in this study. The study revealed Cd pollution in all the water samples analyzed while some of the well water samples analyzed did not fall within WHO standard for Cr content in water. The Zn, Fe and Mn contents of the water samples fell within WHO standard for potable water. Adequate treatment is required for the water before human consumption.

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