FUOYE Journal of Engineering and Technology, Volume 7, Issue 1, March 2022 ISSN: 2579-0617 (Paper), 2579-0625 (Online)

Heavy Metal Pollution Levels of Hand-dug Wells in Close Proximity to Septic Tanks

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ORIGINAL RESEARCH ARTICLE
Received: 23-DEC-2021; Reviewed: 20-JAN-2022; Accepted: 03-MAR-2022
http://dx.doi.org/10.46792/fuoyejet.v7i1.760

Abstract- The aim of this study is to evaluate the levels of selected heavy metal contamination in well water located in close proximity to septic tanks in the South gate area of the Federal University of Technology, Akure (FUTA). Water samples were collected from five (5) randomly selected hand-dug wells in the study area within 50ft (15.4m) distance to septic tanks. The physical attributes of the wells revealed that the wells were well constructed and all the wells sampled were lined with precast concrete pipe (PCP) rings with covers. Five heavy metals namely Cadmium (Cd), Chromium (Cr), Iron (Fe), Manganese (Mn) and Zinc (Zn) were analysed in the laboratory using Atomic Absorption Spectroscopy. Cd, Cr and Mn were present in high concentration in some of the water samples evaluated exceeding the WHO permissible limit. However, Fe and Zn contents of the water fell within WHO standard for potable water. Secondary water treatment is recommended before human consumption.

Keywords- heavy metals, potable, septic tanks, treatment, water samples.

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1 INTRODUCTION

Ground water is water that exists below the land surface in storage media such as wells. According to Wang *et al.* (2020), groundwater is located in subsurface geological strata, hence once contaminated, remediation is difficult and very expensive. Groundwater is an essential water source for residents in both the urban and rural areas of Nigeria (Ayedun *et al.*, 2013). Human health can be adversely affected by groundwater contamination (Peiyui *et al.*, 2021). Momodu & Anyakora (2010) described groundwater contamination as a small undesirable impurity in ground water. The main sources of contamination include agricultural, industrial and municipal sources (Krisat & Al-bakri, 2019).

Heavy metals are major contaminants found in water, they have high densities and are hazardous at small quantities (Cobbina et al., 2015). They include Cadmium (Cd), Chromium (Cr), Iron (Fe), Manganese (Mn) and Zinc (Zn). Industrialization and urbanization have led to the occurrence of heavy metals in water bodies (Nguyen *et al.*, 2016). According to Abong 'O *et al.* (2017), rapid population increasing communities have potentials for heavy metal pollution of available water sources. According to World Health Organization, Cd and Zn are among ten (10) harmful heavy metals of major concern (World Health Organization, 2017). Ojo (2022) reported that Cr and Cd are heavy metals of concern in stream waters. According to Naveedullah *et al.* (2014), increase in the occurrence of heavy metals in water is becoming a serious hazard to human health.

A septic tank is an underground sedimentation tank used for wastewater treatment through the process of biological decomposition and drainage. Septic tanks are used as wastewater treatment options by many householders who also get their potable water from nearby private wells. Septic tanks could fail and leak liberally, causing environmental damage including ground water contamination. Similarly, if a septic tank is situated at close proximity to a drinking well water source, there is possibility of contaminants escaping from the septic tank to impair the well water quality. Wells located less than 50ft from septic tanks are more vulnerable to septic contamination (USEPA, 2009). The main problem associated with the construction of septic tanks and siting of wells in the same area is that most householders do not put the distance between the septic tank and the well into consideration mostly due to insufficient space and overpopulation. Septic tanks at close proximity to wells can interact with groundwater and influence its quality especially its heavy metal content. This study is aimed at investigating the levels of selected heavy metal in well water located in close proximity to septic tanks in Embassy area of FUTA's South Gate, Akure.

2 METHODOLOGY

2.1 STUDY AREA

This study was carried out in the South gate area of the Federal University of Technology, Akure (FUTA). Akure. Akure is a city in south western Nigeria, located about 161 km from the coastal region of the country. The coordinates of its latitude and longitude are 7.250771 and 5.210266 respectively. Akure is home to the prestigious Federal University of Technology Akure (FUTA). Samples used in this research were gotten from five (5) randomly selected hand-dug wells located around the vicinity of the FUTA south gate.

The map of the study area displaying the sampling point is shown in Fig. 1. The study area is densely populated

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Section E- CIVIL ENGINEERING & RELATED SCIENCES
Can be cited as:
Ojo O.M. (2022): Heavy Metal Pollution Levels of Hand-dug Wells in Close Proximity to Septic Tanks, *FUOYE Journal of Engineering and Technology* (FUOYEJET), 7(1), 86-89. http://dx.doi.org/10.46792/fuoyejet.v7i1.760

with a lot of commercial activities and a rapid increase in the rate of construction of buildings (mostly students' hostels). Majority of people living in this area rely on wells as their source of water supply. Unawareness of the standard distance between septic tanks and ground water sources and the need to build more rooms in a small area of land to generate more income has made land owners ignore the safe distance that should exist between a well and a septic tank.

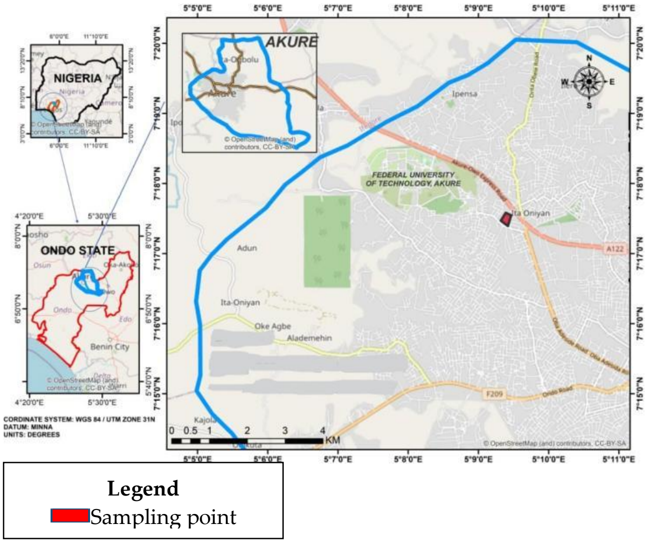

Fig. 1: The study Area

2.2 SAMPLE COLLECTION

The water samples were collected from five wells within 50ft (15.4m) proximity to septic tanks. All the wells sampled were lined with concrete rings and had covers. A measuring tape was used to determine the distance between the wells and the nearby septic tanks. Table 1 shows the description of the five wells used for sample collection.

Table 1. Description of the study wells

Samples	Distance of Well to Septic Tank (m)	Presence of Well Cover	Presence of Concrete Lining
1	5.9	Yes	Yes
2	6.4	Yes	Yes
3	6.4	Yes	Yes
4	11.2	Yes	Yes
5	1.5	Yes	Yes

2.3 LABORATORY ANALYSIS

The well water samples were collected in pre-washed double capped polyethylene bottles in the month of July, 2021 and transported to the Water laboratory of the Department of Chemistry, FUTA within 2 hours of collection in order to preserve the integrity of the water samples. Five heavy metals namely Cd, Cr, Fe, Mn and Zn were analysed in the laboratory using Atomic Absorption Spectroscopy as described by Hussain *et al*. (2012). The samples were digested using 1% nitric acid and stored in 500 mL in double capped polyethylene bottles (Mebrahtu & Zerabruk, 2011). The concentrations of resulting heavy metals were compared with WHO standard for potable water.

3 RESULTS AND DISCUSSION

3.1 CADMIUM (CD)

The results obtained from the test for Cd concentration in the water samples are graphically represented in Fig. 2.

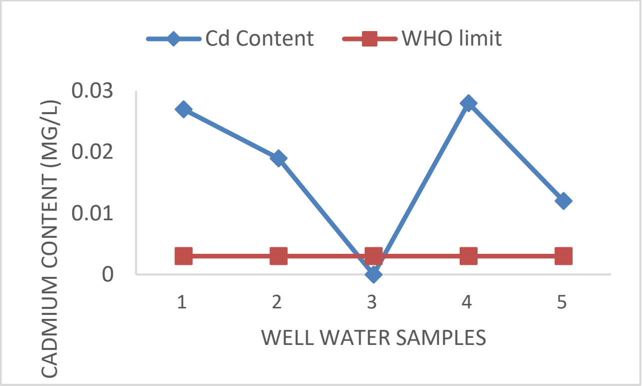

Fig. 2: Cd content of the water samples

Cd concentration in samples 1, 2, 4 and 5 were above the WHO recommendation of 0.003 mg/l, which means excessive contamination of the samples. Likely sources of Cd in water are vehicles' exhausts, pesticides, leakage from engines, and dust containing Cd (Malassa *et al*., 2014). Cd in ground water has also been linked with soil contaminated through leaching as a result discharges from petroleum hydrocarbon (Weggle, 2004). Cd and its compounds have several health effects in humans (Kilunga *et al*., 2017). The health effects of Cd exposure are aggravated by the inability of the body of humans to excrete Cd (Philip & Bernard, 2020). Excessive exposure to Cd can result in kidney, bone and lung disease. Similarly, intake of Cd through water could cause metal poisoning and hormonal changes which could lead to further damage such as kidney failure and cancer (Baby *et al*., 2011, Nta *et al*., 2020).

3.2 CHROMIUM (CR)

The results obtained from the test carried out on Cr concentration in the water samples are graphically represented in Fig. 3.

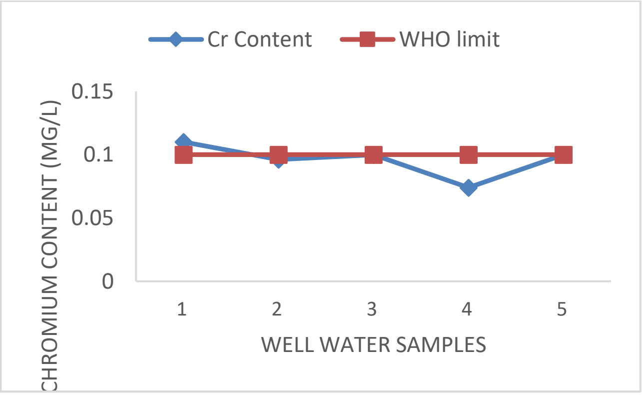

Fig. 3: Cr content of the water samples

From the chart, it can be seen that sample 1 had Cr concentration slightly above the WHO standard of 0.1 mg/L. Samples 2, 3, 4, 5 had acceptable Cr concentration. There are demonstrated instances of Cr being released to the environment by leakage, poor storage, or inadequate industrial waste disposal practices. Consumption of Cr in quantities below 0.1 mg/L may have some health benefits but excessive consumption of Cr may cause diarrhoea, stomach and intestinal bleedings, cramps, and liver and kidney damage (WHO, 2003a).

3.3 IRON (FE)

The result obtained from the Fe concentration test is graphically represented in Fig. 4. It can be observed that all samples have Fe concentration below the WHO maximum concentration for iron in drinking water of 0.3 mg/L. Fe may be introduced into drinking water by coagulating agents used in water treatment plants and where steel, cast iron as well as galvanized iron pipes are used for water distribution and become deadly if consumed in quantities between 200 and 250 mg/kg of body weight (WHO, 2003b).

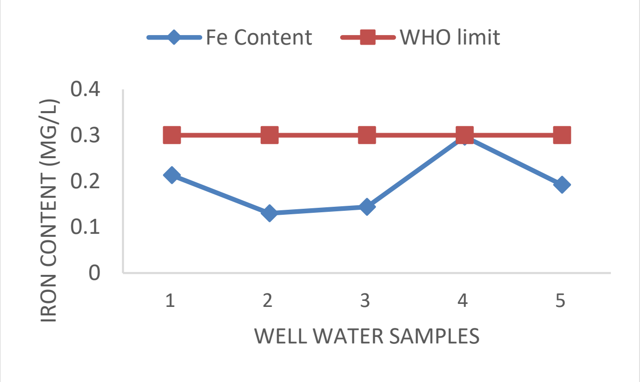

Fig. 4: Fe content of the water samples

3.4 MANGANESE (MN)

The result obtained from Mn concentration test is graphically represented in Fig. 5.

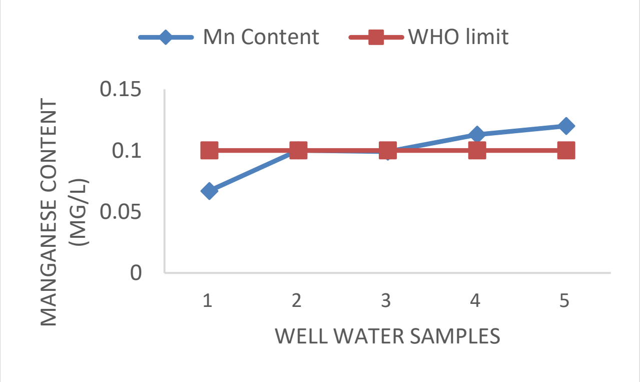

Fig. 5: Mn content of the water samples

From the chart, it can be observed that samples 4 and 5 had Mn concentration above WHO standard for drinking water. The major sources of environmental Mn include sewage sludge and municipal wastewater discharges (WHO, 2004). High levels of Mn can be found in waters associated with low oxygen environments as found in groundwater and Mn concentration above 0.1mg/L may cause water to have an undesirable taste. (WHO, 2011). People who drink water with high levels of Mn for prolonged periods may experience loss of memory and motor skills, specifically, infants may develop education and behavioural problems if they drink water with high concentration of Mn (WQP, 2021).

3.5 ZINC (ZN)

The Zn content of the water samples is graphically represented in Fig. 6.

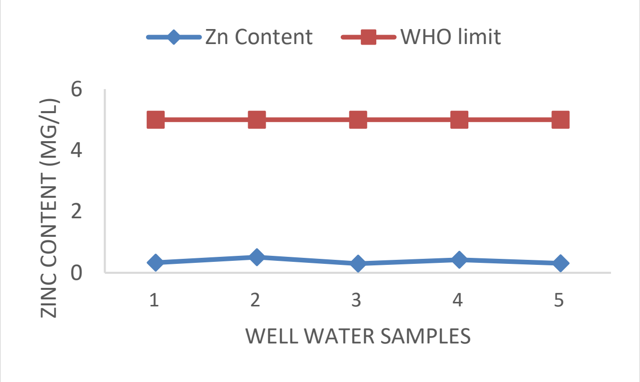

Fig. 6. Zn content of the water samples

From the graph, it can be observed that all five samples had Zn concentration below the maximum Zn concentration guideline of 5 mg/L specified by WHO (2003c). Zn is a necessary nutrient for human growth and development, however drinking water containing high levels of Zn can cause stomach cramps, nausea and vomiting (Damodharan, 2013).

4 CONCLUSION

The study revealed that the Fe and Zn contents of the water fell within WHO standard for potable water. The study also revealed that Cd, Cr and Mn were present in high concentrations in some of the water samples evaluated, exceeding the WHO maximum permissible limits. Cd, Cr and Mn are high risk chemical parameters present in the well water samples analysed. The presence of Mn in the water can be linked to the distance of the Septic tanks to the well water source. However, the presence of Cd and Cr in the water cannot be linked to the distance of the Septic tanks to the well water source since previous studies have linked groundwater contamination with these heavy metals to leaching of petroleum hydrocarbons, effluent from paint industries as well as other industrial activities. A further study is recommended to investigate a possible contamination of these well water samples as a result of industrial activities in the study area. Adequate treatment of well water collected from the study area is recommended before consumption.

ACKNOWLEDGMENT

The author wishes to thank the residents of South gate area of the Federal University of Technology, Akure (FUTA), who graciously allowed their wells to be used in this study.

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http://dx.doi.org/10.46792/fuoyejet.v7i1.760