__Original Research Article__

Investigation of Nickel, Iron, Cadmium, and Lead concentration level in some portable drinking water from well sources in Dutsin-ma, Katsina State, Nigeria.

Abstract

In this study, heavy metal concentration levels (Ni, Fe, Cd, and Pb) in portable well water sample from Dutsin-ma, Katsina State was investigated. A total of ten water samples were collected from some randomly selected wells into a water sampler polyethylene bottle. The samples were digested by adding HNO_3, HCl and heated at 90 ^oC and cooled. Atomic Absorption Spectrophotometer was calibrated and used to measure the heavy elements. The result indicates that the heavy metal concentration levels inwell water samplefrom Dutsimma, Katsina State for Ni, Fe, Cd and Pb are in the range (mean) valuses of 0.005 $\pm$0.0008 – 0.055$\pm$ 0.0024 mg/kg (0.021 mg/kg), 0.119$\pm$0.0011 – 0.768$\pm$0.0006 mg/kg (0.3784 mg/kg), 0.035$\pm$1.876$\pm$0.0092 mg/kg (0.6776 mg/kg), and 0.83$\pm$0.0010 – 1.19$\pm$0.0009 mg/kg (1.451 mg/kg) respectively. Well water samples are widely used by most of the populace of Dutsin-ma as the main source of drinking water. Very negligible level of these heavy element are present and thus pose no harm to the populace. However, constant monitoring of various water sources used for drinkingis essential.

Keyword: Heavy metal, well water, AAS, and Dutsin-ma.

1.0 Introduction

Drinking water as an essential need also has the potential to transmit diseases, poisoning and so on [1, 2]. According to the Ministry of Health, drinking water must meet health requirements that have been determined by the maximum limit. Drinking water parameters are divided into several parts, including the following: physical parameters include odor, amount of dissolved solids, turbidity, taste, temperature and color [4-6]. Chemical parameters include mercury, barium, iron, cadmium, chloride, chromium, manganese and others. Biological parameters include coliform, pathogenic bacteria and viruses. Radioactivity parameters, includingalpha and beta rays [5, 6].

There are 35 metals that are of concern for us because of residential or occupational exposure, out of which 23 are heavy metals: antimony, arsenic, bismuth, cadmium, cerium, chromium, cobalt, copper, gallium, gold, iron, lead, manganese, mercury, nickel, platinum, silver, tellurium, thallium, tin, uranium, vanadium, and zinc [3, 4]. Theseheavy metals are commonly found in the environment and diet. In small amounts they are required for maintaining good health but in larger amountsthey can become toxic or dangerous [1, 3]. Heavy metal toxicity can lower energy levels and damage the functioning of the brain, lungs, kidney, liver, blood composition and other important organs. Long -term exposure can lead to gradually progressing physical, muscular, and neurological degenerative processes that imitate diseases such as multiple sclerosis, Parkinson's disease, Alzheimer's disease and muscular dystrophy [7-

9] . Repeated long-term exposure of some metals and their compounds may even cause cancer. The toxicity level of a few heavy metals can be just above the background concentrations that are being present naturally in the environment. Hence thorough knowledge of heavy metals is rather important for allowing to provide proper defensive measures against their excessive contact [5, 10].

To meet the community'sneed for clean water for drinking, water treatment is carried out from water sources, one of which is well water. Well water can be classified into shallow groundwater (0 - 40 m) and deepground water (> 40 m) [6- 8, 10]. Generally, people use well water that comes from shallow groundwater. The decline in groundwater quality is indicated by the detection of several heavy metal pollutants such as chromium (Cr), copper (Cu), mercury (Hg), lead (Pb) and other metals from industrial waste, landfills (TPA), use of fertilizers. excessive and domestic waste is categorized as a source of direct contaminants, while the source of indirect contaminants is the seepage of surface water that enters groundwater or the atmosphere in the form of rain [11- 13].Therefore, this research work was aimed at appraising the concentrations of some heavy metals in of Dutsinma Drinking water source to ascertain the level of pollution by these metals.

2.0 Materials and Methods

2.1Study Area

Dutsinma is a centrally located town and one of the local government headquarters in Katsina State, Nigeria. It lies within longitude $7^0$30’E and latitude12^0 27’N, around a topographical drainage of river Karaduwa flowing east west. The vegetation of the area is the savannah type, with more grasses than hard wood trees. The average annual rainfall of the area is 817mm. (Batagarawa*et al*.,2010). The town has witnessed influx of people from neighboring villages, as a Local government headquarters. This has increased the concentrations of motor vehicles and some industries over time.

Figure 1: Map of Study Area.

2.2 Collection of water sample

This study was conducted in June, 2022 and the research sample were taken in Dutsimma metropolis, Katsina State, Nigeria. Well water samples were randomly collected from wells used as drinking water sources. A total of ten water samples were collected from the wells selected with the help of a plastic container tied to a rope used by the locals. A water sampler polyethylene bottle of 1L capacity was used for collect the water samples. All the sampling bottles were cleaned with detergent before use and were rinsed with deionized water. At the point of water sample collection, the bottles were rinsed with the respective well water three times before the water samples were collected. The collected samples were properly sealed and labeled and were transported to the laboratory for further treatment.

Comment [M1]: Add the detailed map of samples

2.3 Digestion of water samples

The method developed by the United State Environmental Protection Agency (USEPA) 3005 was adopted for the sample digestion. The samples were digested in a beaker covered with a watch glass by adding 1 mL of 70- 80 % concentrated HNO_3 and 2.5 mL of about 40% concentrated HCl and heated at 90 ^oC using a hot plate for 30 minute. The beaker was then removed and cooled. Each of the digested water samples was filtered through Whatman filter paper into a 100 mL volumetric flask and deionized water and 2 mL of nitric acid to get a clear solution.

2.4 Sample Analysis

The working standard solutions consisting of Ni, Fe, Cd, and Pbeach were prepared from the stock standard solutions of 1000 ppm of the element in nitric acid. Atomic Absorption Spectrophotometer was calibrated and used to measure the heavy elements. The calibration curves were prepared for each element individually by applying linear correlation by least square method. A blank reading was also taken and necessary corrections were made during the various elements concentration calculation. Calibration curves were plotted with different points for each metal standard solution using absorbance against concentrations (mg/L). Immediately after calibration using the standard solutions, the samples solutions were aspirated into the AAS instrument and direct measurements were made for the heavy metal concentration and were recorded.

3.0 Results and Discursion

Table 1 presents the well water samples and the geographical locations of the wells. Heavy metals concentration levels consisting of Nickel (Ni), Iron (Fe), Cadmium (Cd), and Lead (Pb) in porable well drinking water in Dutsimma, Katsina State are shown in Table 2 and Figure 2. Table 3 and Figures 3comparedthe meanconcentrationof heavy elements in the well water samples,other countries and agencies standard limits.

Table 1: Sample code and location.

S/N	Sample	Sample Code		
1	Well water 1	S1	12°27’37.73916”	7°29’45.76092”
2	Well water 2	S2	12°27’47”14884”	7°29’48.84216”
3	Well water 3	S3	12°27’47.32308”	7°29’53.86524”
4	Well water 4	S4	12°26’45.40164”	7°29’27.80412”
5	Well Water 5	S5	12°26’45.40152”	7°29’27.80401”
6	Borehole 1	S6	12°26’40.7832”	7°29’9.53736”
7	Borehole 2	S7	12°26’49.37928”	7°29’22.9326”
8	Borehole 3	S8	12^{o}26’52.3455’’	7°29’28.4320”
9	Borehole 4	S9	12^{o}26’51.6564’’	7°29’32.4529”
10	Borehole 5	S10	12^{o}45’45.8747’’	7°29’34.7054”

Table 2: Heavy metals concentration level (mg/kg).

S/N	Sample Code	Nickel (Ni)	Iron (Fe)	Cadmium (Cd)	Lead (Pb)
1	S1	0.055 ± 0.0024	0.726 ± 0.0022	0.035 ± 0.0003	1.08 ± 0.0015
2	S2	0.005 ± 0.0010	0.768 ± 0.0006	0.043 ± 0.0001	1.07 ± 0.0008

3	S3	0.032 ± 0.0008	1.524 ± 0.0012	1.876 ± 0.0092	1.19 ± 0.0009
4	S4	0.018 ± 0.0011	0.119 ± 0.0011	0.075 ± 0.0042	1.16 ± 0.0024
5	S5	0.005 ± 0.0008	0.022 ± 0.0004	0.597 ± 0.0007	1.32 ± 0.0007
6	S6	0.011 ± 0.0006	0.097 ± 0.0029	1.108 ± 0.0020	1.38 ± 0.0009
7	S7	0.020 ± 0.0010	0.145 ± 0.0014	0.715 ± 0.0011	1.72 ± 0.0006
8	S8	0.015 ± 0.0013	0.099 ± 0.0028	0.533 ± 0.0054	0.83 ± 0.0010
9	S9	0.030 ± 0.0009	0.191 ± 0.0024	1.197 ± 0.0017	1.31 ± 0.0005
10	S10	0.019 ± 0.0005	0.093 ± 0.0019	0.597 ± 0.0009	1.28 ± 0.0008
	Mean	0.021	0.3784	0.6776	1.451

Table 3: Permissible limit for different Countries/ Agency.

Countries/ Agency	**Ni (mg/kg)**	**Fe (mg/kg)**	**Cd (mg/kg)**	**Pb (mg/kg)**
Australia	60.0	N.A	3.0	300.0
China	50.0	N.A	0.5	80.0
Germany	50.0	N.A	1.0	70.0
Canada	100.0	N.A	3.0	200.0
UK	130.0	N.A	1.4	450.0
EU Guideline	75.0	N.A	3.0	300.0
FAO/WHO Guideline	50.0	N.A	3.0	100.0
U.S. EPA	75.0	N.A	85.0	420.0
FEPA Guideline	N.A	400.0	N.A	1.6
Present Study	0.021	0.3784	0.6776	9.451

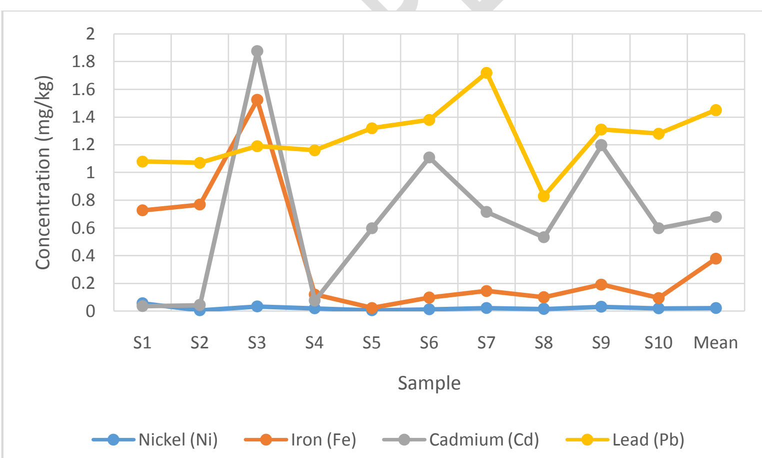

Figure 2: Comparison of concentration level in well water samples in the study area.

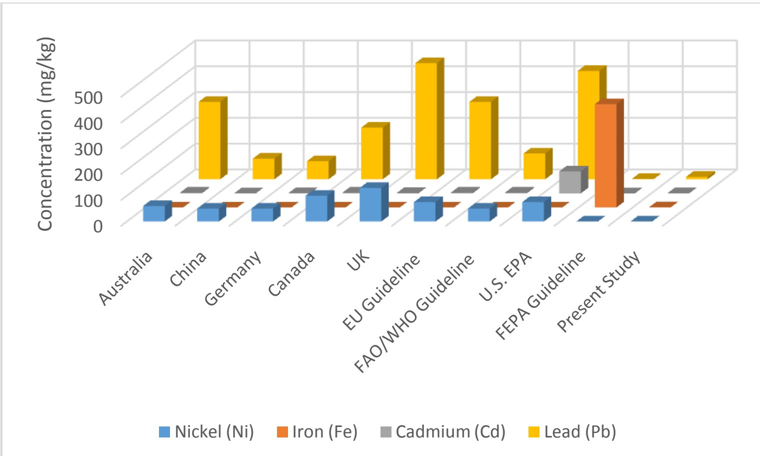

Figure 3: Comparison of permissible limit of some Countries and agencies.

The heavy metal concentration levels inwell water samplefrom Dutsimma, Katsina State has concentration range (mean) valuses for Ni, Fe, Cd and Pb 0.005 ±0.0008 – 0.055± 0.0024 mg/kg (0.021 mg/kg), 0.119±0.0011 – 0.768±0.0006 mg/kg (0.3784 mg/kg), 0.035±1.876±0.0092 mg/kg (0.6776 mg/kg), and 0.83±0.0010 – 1.19±0.0009 mg/kg (1.451 mg/kg) respectively.

On account of the research of authors, the drinking water samples contain metal concentration below the limit set by most countries and agencies (WHO, EUC, EPA, USEPA). Well water samples are widely used by most of the populace of Dutsimma as the main source of drinking water. Very negligible level of these heavy element are present and thus pose no harm to the populace. However, constant monitoring of various water sources is essential. The water can be used for drinking purposes. The probability that the people will suffer through disease on drinking water with lower concentration of heavy metals is very negligible. Theymay not have physiological effects on kidney, digestive system, circulatory system, nervous system etc.

4.0 Conclusion

The heavy metal contamination levels of portable well water sample from Dutsimma, Katsina State were analyzed and determined. Results indicate that the well water samples investigated for Ni, Fe, Cd, and Pb are found to be lower than the recommended limit set by some countries and agencies. This indicate that the well water considered in these study has low contamination by the heavy element considered. However, further study should be carried out to investigate the other heavy element such as Zn, Mg, Cu, etc.

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