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.

A study of the levels of nickel, iron, cadmium, and lead in some portable drinking water from well sources in Dutsin-ma, Katsina State, Nigeria.

Abstract

This study looked into the levels of heavy metal concentrations (Ni, Fe, Cd, and Pb) in a portable well water sample from Dutsin-ma, Katsina State. A water sampler bottle was used to gather ten water samples from various randomly chosen wells. By adding HNO3, and HCl, heating the samples to 90 ^{o}C,, then cooling them, the samples were digested. Heavy elements were measured using a calibrated Atomic Absorption Spectrophotometer.The result indicates that the heavy metal concentration levels in awell water samplefrom Dutsimma, Katsina Statefor Ni, Fe, Cd, and Pb are in the range (mean) values 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. The well water samples are widely used by most of the populace of Dutsin-ma as the main source of drinking water. Very negligible levels of these heavy elements are present and thus pose no harm to the populace. However, constant monitoring of various water sources used for drinkingis essential.

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

1.0 Introduction

The necessity of drinking water also carries the risk of spreading diseases, poisoning, and other conditions [1, 2]. Drinking water must conform to health standards established by the maximum limit, according to the Ministry of Health. There are various partsto drinking water parameters, includingPhysical characteristics including taste, temperature, turbidity, amount of dissolved particles, andcolor [4-6]. A few of the chemical characteristics are mercury, barium, iron, cadmium, chloride, chromium, and manganese. Coliform bacteria, viruses, and pathogenic bacteria are examples of biological parameters. Alpha- and beta-ray radioactivity characteristics [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]. These heavy metals are commonly found in the environment and diet. In small amounts they are required for maintaining good health but in larger amounts they can become toxic ordangerous [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's need for clean water for drinking, water treatment is carried out from water sources, one of which is well water. The well watercan be classified into shallow groundwater (0 - 40 m) and deepgroundwater (> 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),and use of fertilizers. excessive and domestic waste is categorized as a source of direct contaminants, while the source of indirectcontaminants is the seepage of surface water that enters groundwater or theatmosphere in the form of rain [11- 13].Therefore, this research work was aimed at appraising the concentrations of some heavy metals in of Dutsin-ma Drinking water source to ascertain the level of pollution by these metals.

2.0 Materials and Methods

2.1Study Area

Dutsin-ma is a centrally located town and one of the local government headquarters in Katsina State, Nigeria. It lies within longitude 7°30′ Eandlatitude12° 27′ N, aroundthetopographical drainage of river Karaduwa flowing east-west. The vegetation of the area is the savannah type, with more grasses than hardwood trees. The average annual rainfall of the area is 817mm. (Batagarawa*et al*.,2010). The town has witnessed an 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 Source of pollution????? Please explain

2.3Collection of water sample

The research samples for this study were collected in the Dutsin-ma city in Katsina State, Nigeria, in June 2022. The samples of well water taken from wells that provide drinking water were chosen at random. With the use of a plastic container fastened to a rope utilised by the villagers, ten water samples total were obtained from the chosen wells. The water samples were obtained using a 1L polyethylenewater sampler bottle.

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.

2.4Digestion of water samples

The method developed by the United State Environmental Protection Agency (USEPA) 3005 was adopted for 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 ^{o}C using a hot plate for 30 minutes. 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.

2.5Sample Analysis

The stock standard solutions of the element at 1000 ppm in nitric acid were used to create the working standard solutions, which each contained Ni, Fe, Cd, and Pb. Nuclear Absorption Measurements of the heavy elements were made using a calibrated spectrophotometer. The calibration curves were created for each element separately using the least squares method to apply linear correlation.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 sample solutions were aspirated into the AAS instrument and direct measurements were made for the heavy metal concentration and were recorded.

3.0 Results and Discussion

Table 1 presents the well water samples and the geographical locations of the wells. Heavy metal concentration levels consisting of Nickel (Ni), Iron (Fe), Cadmium (Cd), and Lead (Pb) in portable well drinking water in Dutsimma, Katsina State are shown in Table 2 and Figure 2. Table 3 and Figure3compared the mean concentrationofheavy elements in the well water samples,other countries, and the agency’sstandard 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°26’52.3455’’	7°29’28.4320”
9	Borehole 4	S9	12°26’51.6564’’	7°29’32.4529”
10	Borehole 5	S10	12°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/Agencies.

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

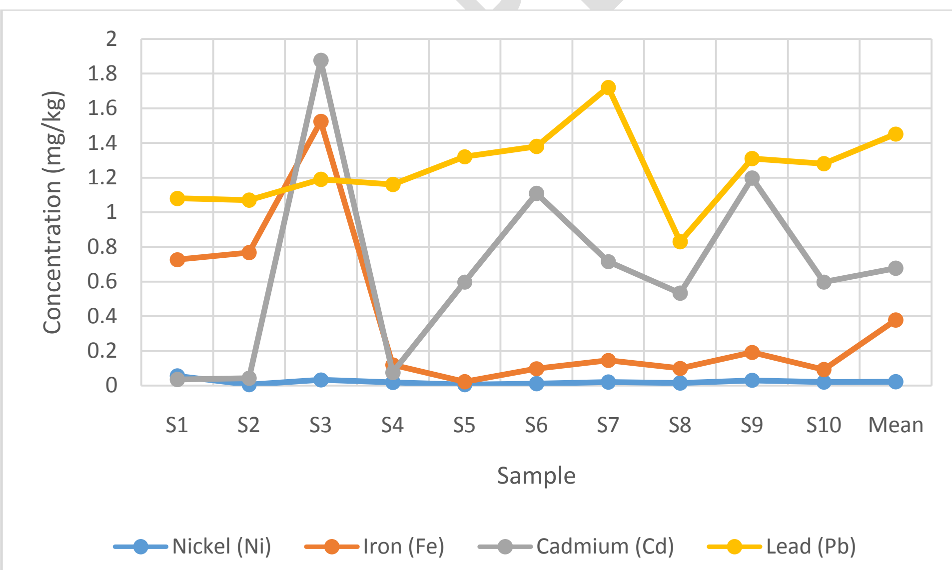

Figure 2: Comparison of concentration level in well water samples in the study area.

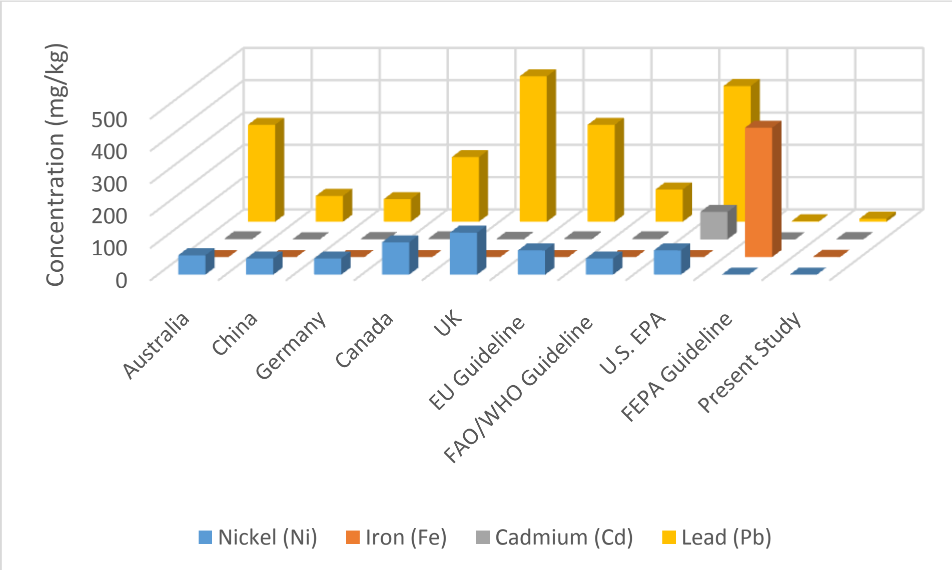

Figure 3: Comparison of permissible limits of some Countries and agencies.

The heavy metal concentration levels in awell water samplefrom Dutsimma, Katsina State haveconcentration range (mean) values 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 theauthors, the drinking water samples contain metal concentrations 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 levels of these heavy elements 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 peoplewillsuffer disease in drinking water with lowerconcentrations of heavy metals is very negligible. Theymay not have physiological effects on the kidneys, digestive system, circulatory system, nervous system, etc.

4.0 Conclusion

We analyzed and identified the amounts of heavy metal pollution in portable well water samples from Dutsimma, Katsina State. The results show that the Ni, Fe, Cd, and Pb levels in the well water samples tested are below the recommended limit established by several nations and agencies. This suggests that the well water used in this research had little heavy element pollution. However,further research needs to be done to look at additional heavy elements like Zn, Mg, Cu, etc.

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