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Determination of Some Heavy Metals from Ground Water Samples Obtained from Selected Motor Parks in Kaduna, Nigeria

Mahmud Mohammed Imam*, Fatima Abubakar, Zara Muhammad

Department of Applied Chemistry, Kaduna Polytechnic, Kaduna, Nigeria

Email address:

mmimam9312@gmail.com (M. M. Imam), fatimaabugus@gmail.com (F. Abubakar), zaramuhammad75@gmail.com (Z. Muhammad)
*Corresponding author

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Abstract: This study is aimed at ascertaining the levels of pollution of borehole and well water of selected motor parks in Kaduna, Nigeria. Borehole and well water samples from Abuja junction, Sabo garage, Television garage, Shaba modern market park, Kawo garage, Mando park were collected and analyzed for lead, cobalt, nickel and cadmium using Atomic Absorption Spectrophotometric technique. Results showed varying concentrations based on location. The results obtained were compared with WHO/NSDWQ standards. Lead was found in excessive levels above the recommended safe limit in the range of 0.04-0.07 mg/l. Nickel and cobalt were within the recommended safe limit in the range of 0.01-0.02 mg/l and 0.002-0.05 mg/l. Cadmium was found in high concentration above safe limits in the range of 0.002-0.012 mg/l. High levels of metals might be associated to the mechanical activities, high vehicle exhaust, municipal waste and other anthropogenic activities within the busy motor parks. The results indicate that most of the samples are contaminated with abnormal levels of lead and cadmium capable of causing health hazards to consumers of the water; this suggests that water found in motor parks require further treatment before consumption.

Keywords: Ground Water, Heavy Metals, Atomic Absorption Spectrophotometer, Kaduna Metropolis, Nigeria

1. Introduction

Water is a polar inorganic compound that is at room temperature a tasteless and odorless liquid, nearly colorless with a hint of blue. Water plays a vital role in the development of communities; hence a reliable source of water is essential for the existence of both human and animals. Water supply is essentially derived from precipitation and is said to be polluted if it is not suitable for the intended purpose [1]. Several heavy metals have been reported to be found in water. Heavy metals are defined as metallic elements that have a relatively high density compared to water. They occur naturally and have a high atomic weight and a density of at least five (5) times greater than that of water [2]. A heavy metal is a dense metal that is usually toxic at low concentrations. Examples include Mercury (Hg), Cadmium (Cd), Arsenic (As), Chromium (Cr), Thallium (Th), Lead (Pb), Titanium (Ti), Vanadium (V), Manganese (Mn), Iron (Fe), Cobalt (Co), Nickel (Ni), Zinc (Zn) and Radium (Ra) [3]. The most ubiquitous of toxic metals in drinking water is lead. Lead and copper can leach from water pipes and soldered joints which deliver water to our tap. Sources of lead exposure include mainly industrial processes, food and smoking, drinking water and domestic sources [4]. In motor parks, ground water is largely used for domestic purposes by mechanics, travelers, and restaurant owners and even for cleansing during prayers. It is very essential and important to test the water before it is used for drinking, bathing, and cleansing, domestic and other purposes. Over the years, seasonal variation, pollution, human anthropogenic activities widely change quality of ground water (borehole and well water), hence the need to examine the physical parameters and presence of any pollutants in a bid to ensure the safety of its use [6]. In motor parks, there are accidental or deliberate releases or discharge of petrol, diesel, solvents, grease, and lubricants on the land and the atmosphere. Many of these petroleum products are organic chemicals that can be highly toxic and hazardous to soil fauna and man. The use of automobiles has led to trace element and heavy metals contaminated soil which has grave consequences for soil dwelling organisms [7]. Due to the nature of industry these days and the mass production in industrial plants and farms, we have a lot of chemical run-off that flows into the nearby rivers and water sources. Metals and solvents flow out of factories and into the water, polluting the water and harming the wild life. Pesticides from farms are like poison to the wildlife in the water and kill and endanger like aquatic life. If humans or birds eat these infected fish, the toxins are transferred to us and we swallow these dangerous pesticides and toxins, affecting our health. Petroleum is a different type of chemical pollutant that dramatically affects the aquatic life. This oil kills the cat fish and marine life and sticks to the feathers of birds, causing them to lose the ability to fly [8]. Heavy metal toxicity has proven to be a major threat and there are several health risks associated with it. The toxic effects of these metals, even though they do not have any biological role, remain present in some or the other form harmful for the human body and its proper functioning. They sometimes act as a pseudo element of the body while at certain times they may even interfere with metabolic processes. Few metals, such as aluminum, can be removed through elimination activities, while some metals get accumulated in the body and food chain, exhibiting a chronic nature. Various public health measures have been undertaken to control, prevent and treat metal toxicity occurring at various levels, such as occupational exposure, accidents and environmental factors. Metal toxicity depends upon the absorbed dose, the route of exposure and duration of exposure, i.e. acute or chronic. This can lead to various disorders and can also result in excessive damage due to oxidative stress induced by free radical formation [9]. The aim of this research work is to determine the level of some heavy metal contents in borehole and well water found in selected motor parks within Kaduna metropolis.

2. Materials and Methods

2.1. Sampling

Groundwater from six (6) different motor parks within Kaduna metropolis were collected. The sample bottles were washed properly and dried prior to the collections. The samples collected were labeled and then taken to the laboratory for analysis. The samples were coded. These samples were obtained from boreholes and hand dug wells. Bore hole water and well water samples for heavy metal determination were collected from six (6) different sites of the Kaduna metropolis. These sites and their codes were shown below.

TG	Television Garage
KG	Kawo Motor Park
SMM	Shaba Modern Motor Park
AJ	Abuja Junction
MP	Mando park
SG	Sabo Garage

2.2. Sample Preparation

50 cm^3 of the sample was measured into a clean 100 ml beaker. 10 cm^3 concentrated nitric acid (HNO_3) was added. The beaker with the content was placed on a hot plate and digested in a fume cupboard until the content reduced to about 20 ml by volume. The content was allowed to cool and filtered into a 100 ml volumetric flask with whatmann filter paper and made up to mark with distilled water. These was then transferred into a properly labelled sampling bottle. This was repeated with all samples to be analyzed. The heavy metals such as Cd, Pb, Co and Ni were determined using ICE 3000C113300129 v 1.30 Atomic Absorption Spectrophotometer. Other parameters such as pH, Conductivity, Turbidity, Total dissolved solid (TDS) and Total alkalinity were determined in accordance with the standard method recommended by the Association of official Analytical Chemists.

3. Results and Discussion

The mean concentration of some heavy metals and that of some parameters such as PH, Conductivity, Turbidity, Total dissolved solid (TDS) and Total alkalinity were shown in the tables below.

Table 1. *Physico-chemical parameters of the samples of borehole and well water from selected motor parks in Kaduna metropolis.*

Sample Codes	Temp (°C)	pH	TDS (mg/l)	Total Alkalinity (mg/l)	Electrical Conductivity (µs/m)	Turbidity (NTU)
TG	23	5.47	764	190	160.1	4
KG	22	6.54	653	200	1296	0.24
AJ	26	6.04	1620	300	358	3
SMM	26	4.23	506	120	130.4	0.7
MP	22	6.88	978	870	203	0
SG	20	5.53	909	150	190	2

Table 1 shows the physico-chemical analysis of Bore hole water and well water. The turbidity of samples obtained was all within the WHO permissible limit of 5 NTU, the occurrence of turbidity may be seasonal (John, 1999). Television garage borehole with sample code (TG) had the highest turbidity of 4 NTU while Mando garage well water had the lowest turbidity of 0.7 NTU. Excessive turbidity, or cloudiness, in drinking water is aesthetically unappealing, and may also represent a health concern. Turbidity can provide food and shelter for pathogens. If not removed, turbidity can promote regrowth of pathogens in the distribution system, leading to waterborne disease such as cholera, typhoid fever etc. outbreaks. Although turbidity is not a direct indicator of health risk, numerous studies show a strong relationship between removal of turbidity and removal of protozoa. The particles of turbidity provide "shelter" for microbes by reducing their exposure to attack by disinfectants. Microbial attachment to particulate material has been considered to aid in microbe survival. Fortunately, traditional water treatment processes have the ability to effectively remove turbidity when operated properly [10]. The pH of the water samples obtained from Abuja junction (BH), Television garage (BH), Sabo garage (BH) and Shaba modern market (WW) collected were below the WHO permissible limit with pH values of 6.0, 5.5, 5.3 and 4.2 respectively while samples from Mando park (WW) and Kawo park (WW) were within the permissible limit (6.5-8.5). These were slightly below the guideline limit of 6.5-8.5, thus indicating corrosiveness. However, an average pH of 6.81 is recorded for the entire study area; this is in consistent with results obtained [4]. The World Health Organization recommends a pH value of 6.5 or higher for drinking water to prevent corrosion. Although, a pH above 8.0 would be disadvantageous in the treatment and disinfection of drinking water with chlorine. However, pH values between 6.5 and 8.5 usually indicate good water quality and this range is typical of most drainage basins of the world [11]. The electrical conductivity of samples collected within the sampling period were all within the WHO permissible limit of 1000 µs/m except for Kawo garage (WW) with 1296 µs/m. Electrical conductivity gives an indication of the amount of total dissolved substitution in water [12]. The results of the physico-chemical analysis obtained indicates that the total alkalinity of samples collected within the sampling period were all within the WHO permissible limit of 600 mg/l with the exception of Mando park (WW) at 870 mg/l. an overall excess of alkalinity in the body may cause gastrointestinal issues and skin irritations. Too much alkalinity may also agitate the body's normal pH, leading to metabolic alkalosis, a condition that may produce the following symptoms: nausea, vomiting, hand tremors, muscle twitching, tingling in the extremities or face, confusion. The total dissolved solids (TDS) of samples collected from the sampling sites were all within the WHO permissible limit of 1000 mg/l with the exception of Abuja junction (BW) which is 1620 mg/l. Water containing TDS less than 1000 mg L-1 could be considered to be "Fresh water" and good enough both for drinking and irrigational purposes, as this would not affect the osmotic pressure of soil solution [6, 13].

Table 2. *The mean concentration (mg/l) of Cd in borehole and well water of selected motor parks.*

Sampling sites	W. W (mg/l)	Sampling sites	B. W (mg/l)
KW	2.7±0.009	TG	ND
MD	0.03±0.01	SG	0.01±0.002
SMM	0.015±0.012	AJ	0.01±0.004

Table 2 shows that the mean concentrations of cadmium in borehole and well water samples obtained from selected motor parks and was found to be above the permissible limit of 0.003 mg/l given by NSDQW, (2007) and WHO, (2008) with an exception of sabo garage with mean concentration (0.002 mg/l). Well water from shaba modern market had the highest mean concentration of 0.012 mg/l while borehole water from sabo garage had the lowest concentration of 0.002 mg/l. The result obtained in this present study is similar to that reported by Kolo and Waziri in the determination of some heavy metals in borehole water samples of selected motor parks in Maiduguri which ranged from 0.21-0.01 mg/l [14]. The variation in concentration of cadmium in well and borehole water from selected motor parks is shown in the figure 3.

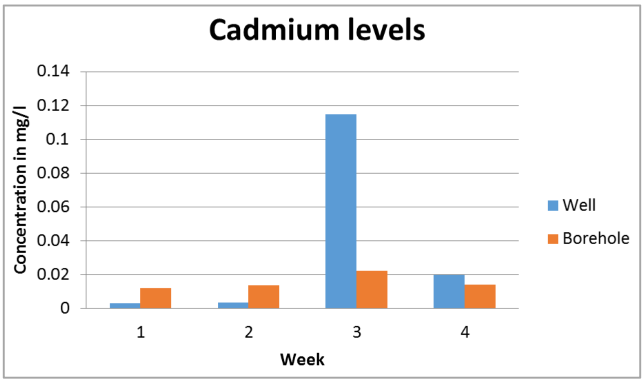

Figure 1. *Variation of cadmium in selected motor parks.*

Table 3. *Mean concentration (mg/l) of lead in well and borehole water of selected motor parks.*

Sampling sites	W. W (mg/l)	Sampling sites	B. W (mg/l)
KW	17.06±0.037	TG	ND
MG	9.33±0.038	SG	9.38±0.05
SMM	11.33±0.066	AJ	ND

Table 3 shows that mean concentrations of lead in borehole and well water samples from selected motor parks (Kawo garage, Mando garage, Shaba modern market park, Televison garage, Sabo garage and Abuja junction park) which were found to be above the permissible limit of 0.01 mg/l given by and WHO. Well water from shaba modern market park (0.07 mg/l) had the highest mean concentration while well water from kawo garage (0.04 mg/l) had the lowest mean concentration. No trace of lead was found in borehole water of television garage and Abuja Junction Park. In the present study, the obtained concentration of lead was found to be lower than that obtained by Odibia *et al.,* analyzed for lead in ground water found in Bantayi and Rafin Kada settlements of Wukari local government area in Taraba state which ranged from 0.108-0.184 mg/l [15]. The high concentration of lead (pb) in this study is as a result of industrial pollution in the sampling sites. Constant exposure to lead may lead to delays in physical or mental development in infants and children, while adults may have kidney problems and high blood pressure. Lead contaminate water due to corrosion of household plumbing systems, industrial waste, mining and erosion of natural deposits [10]. The variation of lead in well and borehole water from selected motor parks is shown in the figure 2:

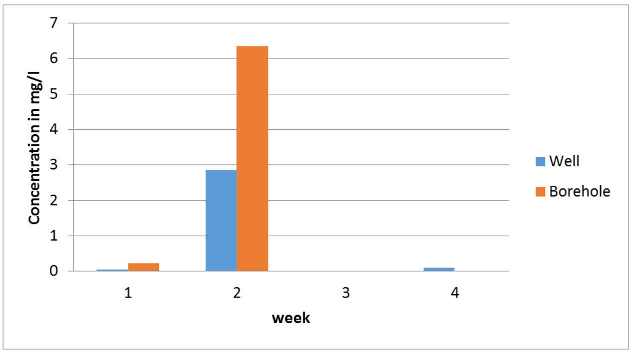

Figure 2. *Variation of lead in selected motor parks.*

Table 4. *Mean concentration (mg/l) of Cobalt in borehole and well water of selected motor parks.*

Sampling sites	W. W (mg/l)	Sampling sites	B. W (mg/l)
KW	0.31±0.11	TG	0.51±0.045
MG	0.34±0.05	SG	0.48±0.048
SMM	0.68±0.002	AJ	0.59±0.03

Table 4 shows that the mean concentrations of cobalt in borehole and well water samples obtained from selected motor parks was found to be within the stipulated limit of 0.05 mg/l given by WHO, (2008). Well water from mando garage (0.05 mg/l) had the highest mean concentration while well water from shaba modern market had 0.002 mg/l which the lowest mean concentration. In the present study, the obtained concentration of cobalt was found to be lower than that obtained by Senthill *et al.,* who analyzed for cobalt in ground water found in Coastal Aquifers of Pondicherry Region, India which ranged from 0.0024-0.0506 mg/l [16].

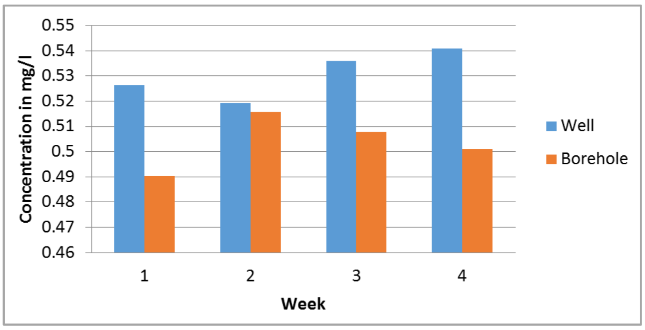

Figure 3. *Variation of cobalt in selected motor parks.*

Table 5. *Mean concentration (mg/l) of Nickel in borehole and well water in selected motor parks.*

Sampling sites	W. W (mg/l)	Sampling sites	B. W (mg/l)
KW	ND	TG	ND
MG	10.43±0.131	SG	0.02±0.015
SMM	ND	AJ	ND

Table 5 shows that the mean concentrations of Nickel in borehole and well water samples obtained from selected motor parks was found to be within the permissible limit standard of 0.02 mg/l given by WHO. Borehole water from sabo garage (0.02 mg/l) has the highest mean concentration and mando garage (0.01 mg/l) with the lowest mean concentration, while samples from kawo garage, shaba modern market park, television garage and Abuja junction showed no traces of nickel. The high concentration of Nickel in this study is as a result of industrial effluent in the sampling sites and natural sources (acid rain and soil weathering). High concentration of nickel beyond the permissible limit may cause dermatititis (insensitivity in people).

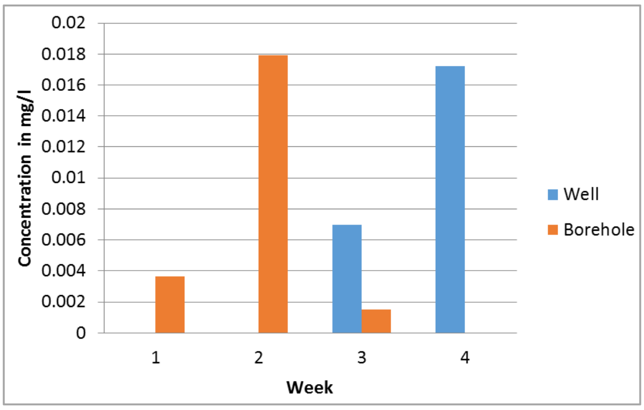

Figure 4. *Variation of Nickel in selected motor parks.*

4. Conclusion

It was observed from the analysis carried out to ascertain the level of some heavy metals in water samples collected from selected motor parks of Kaduna metropolis, the research revealed that concentration of lead (pb) exceeds the permissible limits recommended by WHO and NSDQW for both borehole and well water samples. The concentration of nickel (Ni) was with within the permissible limit for both borehole and well water samples with the exception of Mando garage (well water). Cadmium (Cd) levels in borehole and well water were within the permissible limits recommended by WHO. Cobalt (Co) levels exceed the permissible limit recommended by WHO. Heavy metals pose a number of hazards to human health. Therefore, their concentration in the environment and their effect on human health should be monitored regularly.

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