DETERMINATION OF LEAD IN WELL AND BOREHOLE WATER SAMPLES IN BAUCHI, NIGERIA

Hassan, U. F[1]; Gende, H. U[1]; Yeboah, P[1]. & Baba, H[2].
[1]Chemistry Programme, Abubakar Tafawa Balewa University, Bauchi, Nigeria.
[2]Chemistry Department, College of Education, Minna, Nigeria

Abstract

Water samples from 12 boreholes and 18 wells were collected in Bauchi from February to April, 2010 and analyzed for lead concentrations (mgdm^{-3}) in triplicate using Atomic Absorption Spectrophotometric Technique. The mean levels of lead obtained ranged from 0.002 to 0.13 mgdm^{-3}and 0.001 to 0.17 mgdm^{-3} for borehole and well water samples with corresponding grand mean concentrations of 0.032 mgdm^{-3} and 0.058 mgdm^{-3} for the same water source. The variations in the concentrations of lead determined in the borehole and well water samples of Bauchi were found to be statistically the same (P<0.05 and P<0.10) as determined by a two-tailed Mann-Whitney test. The grand mean concentration of lead determined for the two water sources investigated were found to be contaminated with lead above the 0.01 mgdm^{-3} permissible limit set by World Health Organization (WHO) drinking water guidelines.

Key words: Borehole water, well water, lead, two-tailed Mann-Whitney test.

Introduction

Although water has an essential role in supporting human life, it also has a great potential for transmitting diseases and illnesses if contaminated (Musa et *al*, 2004). About 80% of ill-health in most developing countries like Nigeria was reported to be associated with contaminated and unsafe water (Seth *et al*, 2002). This is the major reason why water that has been detected to contain any amount of impurities should be completely avoided (Santillan-Medraw & Jurinak, 1992).

Population growth, coupled with other factors such as urbanization, agricultural activities, industrial and commercial processes, has resulted in the accumulation of wastes and pollutants which end up in water bodies, thereby polluting them (Hutchinson & Meema, 1987; Dike et al, 2004) in Hassan (*et al*, 2009).

Lead is a potentially hazardous trace metal to most forms of life, and is considered to be toxic and relatively accessible to aquatic organisms. Lead is a neurotoxic metal that may accumulate in our body and has no biological values. Lead metal is toxic because when ingested or inhaled and absorbed, it can harm virtually every system in the human body, especially brain, kidney and reproductive system since it disrupts enzyme system mediated by iron, zinc and calcium that are important to the body (Funtua et al, 2007; Ojiodu & Atasie, 2005 in Hassan *et al*, 2009).

Human exposure to lead occurs primarily through particulate materials of lead in sources of drinking water, lead based paints on painted surfaces, plumbing materials that have been lead-coated and used over a long period of time. Mechanical workshops, illegal mining areas and refuse dumpsites are other common sources of human exposure (U.S.EP.A, 1990).

Accumulation of lead in different concentrations in the body have been found to cause poisoning of the blood associated with broad health effects such as inhibition of the biosynthesis of hemoglobin, acute headache, abnormal movements in the body, fertility problems, dizziness and renal problems, which often leads to death (Bryce & Clarkson, 2005). Lead is toxic to children and the young of other species. A number of detailed studies aimed at assessing the health effects of chronic lead exposure in children have revealed significant effects on intelligence and neuropsychological performance. Lead and cadmium are industrial pollutants which have strong negative effects on human and animal health (Albaiges, 1981; Martin, 1982; Szkoda & Zmudzki, 2005 in Hassan *et al*, 2009). Lead is also toxic to plants at concentration range of 3-20 ppm depending on plant species, to animals at a concentration of 1 mg/day and humans at 10 g/day (Bowen, 1979).The aim of this study is to:

(i) determine the concentration of lead in the borehole and well water samples in Bauchi metropolis

(ii) compare statistically the concentrations of the lead in the two water sources under investigation.

Materials and Method

Analytical reagent (AnalaR) grade chemicals and distilled deionized water were used for the determination throughout the study. All glass wares and plastic containers used were washed with detergent solution, followed by 5% (v/v) nitric acid, rinsed with tap water and finally with distilled deionized water. The apparatus were then allowed to dry (Walter, 1995).

Sampling and Sample Treatment

Water samples were collected from twelve (12) boreholes and eighteen (18) wells distributed throughout Bauchi, Nigeria (Fig.1). 1.0 dm^3 of water samples were collected three times in screw-capped plastic jars from February to April, 2010 in each site and labelled appropriately for analysis. A total of 36 and 54 water samples were collected from all the boreholes and wells respectively and analyzed for lead. The water samples collected were filtered using Whatman number 1 filter paper and preserved by acidifying with 2.0 cm^3 of concentrated nitric acid (Musa *et al*, 2008).

Digestion Procedure

50.0 cm^3 of the water sample was measured into a 100.0 cm^3 beaker and 10.0 cm^3 of concentrated nitric acid was added. The beaker and its content were moderately heated on a hot plate at 80^0C for about 2.0 hours until brown fumes of nitric acid appeared (LPFWA, 2004).Heating continued until the content reduced to about 10.0 cm^3 volume. After cooling, the content was quantitatively transferred into a 50.0 cm^3 volumetric flask and made to volume with water before transferring into a smaller screw-capped plastic jar and stored at room temperature for the determination of lead using a Buck Scientific Model 210-VGP Atomic Absorption Spectrophotometer (Musa *et al*, 2004). This procedure was repeated for all the samples under investigation.

Results and Discussion

The concentrations of lead in well water and borehole water of Bauchi determined in this study are shown in Tables 1 and 2 respectively. The differences in the mean concentrations of lead determined in the well and borehole water samples of Bauchi were found to be statistically the same ($P<0.05$ and $P<0.10$) as determined by a two-tailed Mann-Whitney test.

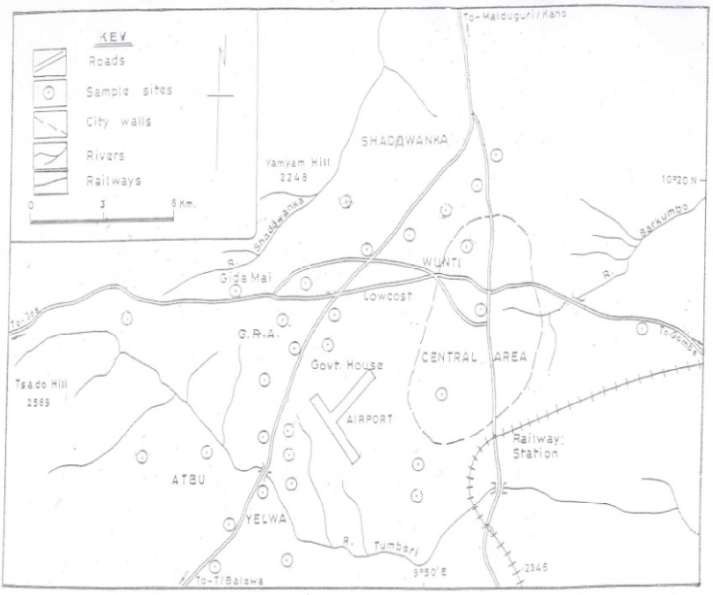


Fig. 1 Map of Bauchi metropolis showing sample sites.

Table 1: The mean concentrations and range of lead in $mgdm^{-3}$ in well water samples of Bauchi

S/No.	Sampling location	Mean concentration and range
1	Yalwa market	0.090
		0.00-0.100
2	Yalwan makaranta	0.170
		0.170-0.180
3	Lushi, Bakery Road	0.040
		0.040-0.040
4	Police Barrack, Rafin Zurfi	0.008
		0.008-0.008
5	Old Dass Park	0.007
		0.007-0.008
6	State Secretariat	0.003
		0.003-0.003
7	Federal Low-Cost A	0.048
		0.048-0.049
8	Federal Low-Cost B	0.061
		0.060-0.061
9	Gidan Mai, Jos Road	0.091
		0.091-0.092
10	Muda Lawal Market	0.130
		0.130-0.140
11	Muda Lawal Motor Park	0.150
		0.150-0.160
12	Bank Road	0.002
		0.002-0.002
13	Gombe Road	0.043
		0.043-0.044
14.	Wunti Market	0.061
		0.061-0.061
15	Sam Nuyoma Street	0.001

		0.001-0.001
16	Yandoka Road	0.110
		0.110-0.110
17.	Bauchi Hospital Management Board	0.002
		0.002-0.002
18	Bauchi State Agricultural Dev. Prog.	0.033
		0.033-0.034
	Grand mean =	0.058 $mgdm^{-3}$

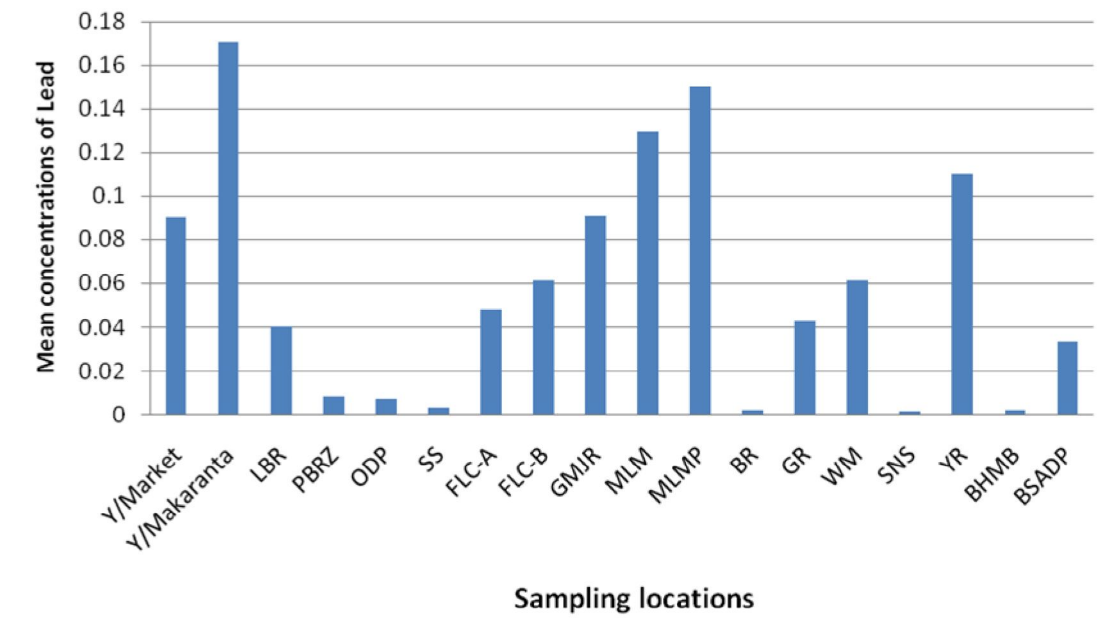
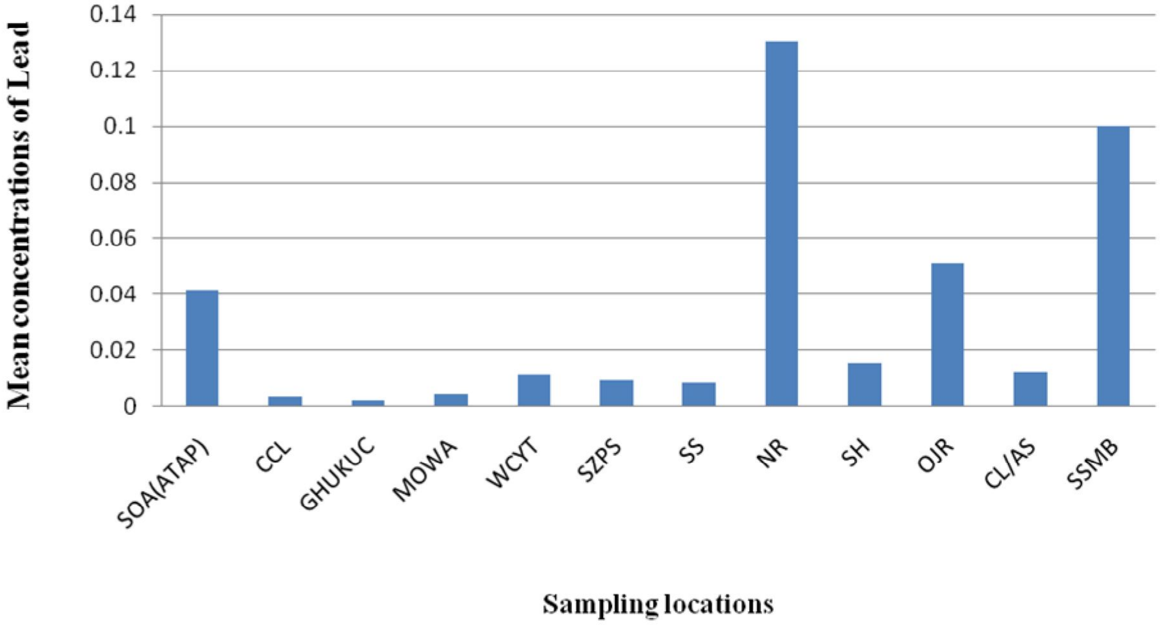


Fig 2 : The mean concentrations of Lead in $mgdm^{-3}$ in…

S/No.	Sampling location	Mean concentration and range
1	School of Agriculture (ATAP)	0.041
		0.039-0.041
2	Christian Corpers Lane	0.003
		0.003-0.003
3	General Hassan Usman Unity College	0.002
		0.002-0.002

4	Ministry of Women Affairs	0.004
		0.004-0.004
5	Winners Charpel, Yalwan Tudu	0.011
		0.010-0.012
6	Sa'adu Zungur Primary School	0.009
		0.007-0.010
7	State Secretariat	0.008
		0.008-0.008
8	Nassarawa Road	0.130
		0.110-0.140
9	Specialist Hospital	0.015
		0.014-0.017
10	Old Jos Road	0.051
		0.050-0.052
11	College for Islamic/Arabic Studies	0.012
		0.012-0.012
12	Special Schools Management Board	0.100
		0.100-0.100
	Grand mean =	0.032 $mgdm^{-3}$



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The mean concentrations of lead determined in Bauchi well water samples ranged from 0.001 to 0.17 mgdm^{-3} with a grand mean concentration of 0.058 mgdm^{-3}. Sam Nuyoma street well had the lowest mean lead concentration of 0.001 mgdm^{-3}, while Yalwan Makaranta had the highest mean lead concentration of 0.17 mgdm^{-3}. This could be attributed to the fact that Sam Nuyoma Street is less densely populated compared with other sampled locations, including Yalwan Makaranta.

Lead was detected above 0.01 mgdm^{-3} permissible limit set by World Health Organization (WHO) in twelve out of the eighteen well water sampling locations. This therefore shows that 66.67% of the Bauchi well water samples analysed are contaminated with lead above the 0.01 mgdm^{-3} WHO drinking water guidelines. The grand mean concentration of lead in the well water samples of Bauchi (0.058 mgdm^{-3}) was far below that of Musa *et al*, 2008 (0.25 mgdm^{-3}) in Zaria. Another reason for the low grand mean value of lead reported here could be due to low industrial activities in Bauchi compared to Zaria town.

The mean concentration of lead as determined in Bauchi borehole water samples ranged from 0.002 to 0.13 mgdm^{-3} with a grand mean concentration of 0.032 mgdm^{-3}. General Hassan Usman Unity College borehole had the lowest mean lead concentration of 0.002 mgdm^{-3}, while Nassarawa road borehole had the highest mean lead concentration of 0.13 mgdm^{-3}. The few borehole water samples with relatively high lead concentrations might be due to peculiar human activities and lack of good drainage systems within the sampling sites. Leaching from various domestic wastes, organic matter, vulcanizing shops, mechanical workshops, as well as lead-based paintchips flaking from homes and offices associated with the areas could be responsible for the relatively high mean lead values. Another reason could be due to the geological nature of the areas. It was also reported that the origin of lead pollution could be from natural sources (Omuku et al,2009). The boreholes affected are Old Jos Road (0.051 $mgdm^{-3}$), Special Schools Management Board (0.10 $mgdm^{-3}$) and Nassarawa Road (0.13 $mgdm^{-3}$) respectively.

Lead was also detected in some of the boreholes above the 0.01 $mgdm^{-3}$ permissible limit set by World Health Organization (WHO). This also shows that 58.33% of the Bauchi borehole water samples analyzed are contaminated with lead above the 0.01 $mgdm^{-3}$ WHO drinking water guidelines. Comparatively, the grand mean concentration of lead in the borehole water samples of Bauchi (0.032 $mgdm^{-3}$) was below the grand mean lead level (0.158 $mgdm^{-3}$) of Zaria (Musa *et al*, 2008). At high concentrations, lead can cause irreversible brain damage, seizure, coma and death if not treated immediately. Kidney disease, both chronic nephropathy and acute is a feature of lead toxicity (Hassan *et al*, 2009). It has also been found to cause infertility in men by disrupting semen production and quality (Bryce and Clarkson, 2005).

Conclusion

The determination of lead in well water and borehole water of Bauchi above the permissible limit set by WHO is a problem of growing concern in the town more especially in the sampled sites where the concentration of lead is relatively high. There was no published data on the determination of lead in water in the study area of Bauchi to compare the results with; hence this research work can be used as a baseline study for future work.

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