Determination of Lead Levels in Drinking Water in Some Areas of Khartoum City and Gezira State, Sudan

By Mohammed Mubarek Awad Ahmed & Khalifa Al-Faloos

Asmaria University, Saudi Arabia

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Keywords: *lead, contamination, drinking water, atomic absorption.*

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I. Introduction

Humans are exposed to lead through inhalation of air pollutants, consumption of contaminated drinking water, exposure to contaminated soils or industrial waste, or consumption of contaminated food. Food sources such as vegetables, grains, fruits, fish and shellfish can become contaminated by accumulating metals from surrounding soil and water. lead exposure causes serious health effects, including reduced growth and development, cancer, organ damage, nervous system damage, and in extreme cases, death. Exposure to heavy metals, such as mercury and lead, may also cause development of autoimmunity, in which a person's immune system attacks its own cells. This can lead to joint diseases such as rheumatoid arthritis, and diseases of the kidneys, circulatory system, and nervous system. (ToxFaQs, 1993).

Lead rarely occurs naturally in water, the natural concentration of lead in surface water has been estimated to be 0.02 μg/liter.(WHO,1987).

Most lead contamination takes place at some point in the water delivery system. This occurs as a result of corrosion, the reaction between the water and lead in parts of the water delivery system. Materials in the water delivery system which may contain lead include service connections, pipes, solder, and brass fixtures.(Chisolm ,2004).

Author α σ: Department of Chemistry Faculty of Science, AL- Asmaria University.

II. Materials and Methods

a) Drinking water samples

Drinking water samples were collected in Khartoum and some villages of Gezira state (Arbagi, Wadshantoor, Dagala, Saleem) from 30 houses which water supply by metal pipes in Wadshantoor, Dagala, Saleem.Samples from Arbagi where water supply by plastic pipes, a number of samples were collected from the Blue Nile for comparative.Drinking water was sampled in 1.25 liter plastic bottles, the interior of which being previously rinsed three times with sampled water. To preserve the water it was acidified with HNO_3. Table (1) Samples location of drinking water.

Site	Number of Samples	Samples Code
Blue Nile	5	1A
Arbagi	7	2A
Dagala,Wadshantoor, Saleem	18	3A
Khartoum	20	4A
Total	50	

b) Atomic Absorption Spectrophotometer Method

i. Principle of the method

The technique makes use of absorption spectrometry to assess the concentration of an analyte in a sample. It requires standards with known analyte content to establish the relation between the measured absorbance and the analyte concentration and relies therefore on Beer-Lambert law. In short, the electrons of the atoms in the atomizer can be promoted to higher orbitals(excited state) for a short period of time(nanoseconds) by absorbing a definite quantity of energy. This amount of energy is specific to a particular electron transition in a particular element. In general each wavelength corresponds to only one element, and the width of an absorption line is only of the order of a few picometers (pm), which gives the technique its elemental selectivity. The radiation flux without a sample and with a sample in the atomizer is measured using a detector, and the ratio between the two values(the

absorbance) is converted to analyte concentration or mass using the Beer-Lambert law.(A. Walsh ,1955).

ii. *Reagents*

- Mithyl isobutyl ketone(MIBK)

- Diethyldithiocarbamate(DDC): 20g of diethyldithio - carbamic acid- sodium salt were Dissolved in 380 ml of deionized water and filtered through a 0.45-micron Millipore filter. The filtrate was extracted twice with 15ml portions of MIBK.

- Phthalate buffer: 102g of potassium biphthalate were dissolved in 500ml of deionized water, 14ml of 1M HCl were added and diluted to 1 liter with deionized water.

- Hydrochloric acid: HCl concentrated.

- Sodium hydroxide: NaOH 1M. 4g of NaOH were dissolved in 100ml deionized water.

iii. *Standard solutions*

Standard containing 10,25,50,75, and 100μg/literof Pb were prepared (acidified to maintain pH at 1- 2)and treated as described below.

iv. *Sample Preparation*

1. A 200ml aliquot were filtered through a 0.45 micron Millipore filter. The filtrate was acidified with 16 drops of concentrated HCl.

2. 2-100ml of the acidified water sample were transferred into a 250ml Erlenmeyer flask.

3. 3- A 200ml of the phthalate buffer were added and adjusted pH to 3.6.

4. 7ml of the DDC solution were added, transferred to a 500ml separatory funnel, and 15ml MIBK were added.

5. 4- The solution was Shaken vigorously for 30S, allowed phases to separate, and drawn off the MIBK layer into a glass- stoppered test tube.

6. (Perkin- Elmer Co. ,1994)

III. Results and Discussion

Results of the atomic absorption spectrophotometry method about the concentrations of lead in drinking water samples were listedin the tables below:

Table 2 : Quantities of lead in drinking water samples in ppm as determined by the atomic absorption method

No.	Sample Code	Lead Conc.(ppm)	No.	Sample code	Lead Conc.(ppm)
1	1A	0.03	26	3A	0.03
2	1A	0.00	27	3A	0.03
3	1A	0.00	28	3A	0.03
4	1A	0.01	29	3A	0.04
5	1A	0.02	30	3A	0.03
6	2A	0.00	31	4A	0.04
7	2A	0.03	32	4A	0.05
8	2A	0.01	33	4A	0.04
9	2A	0.02	34	4A	0.04
10	2A	0.01	35	4A	0.05
11	2A	0.02	36	4A	0.04
12	2A	0.03	37	4A	0.05
13	3A	0.04	38	4A	0.04
14	3A	0.03	39	4A	0.05
15	3A	0.03	40	4A	0.07
16	3A	0.04	41	4A	0.04
17	3A	0.03	42	4A	0.06
18	3A	0.03	43	4A	0.04
19	3A	0.04	44	4A	0.05
20	3A	0.03	45	4A	0.04
21	3A	0.03	46	4A	0.05
22	3A	0.03	47	4A	0.05

23	3A	0.03	48	4A	0.04
24	3A	0.03	49	4A	0.04
25	3A	0.04	50	4A	0.05

Table 3 : Statistic analysis of concentration of lead in drinking water

Descriptives

Group	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Blue Nile	5	0.0120	0.01304	0.00583	0. 0042	0.0282	0.00	0.03
Arbagi	7	0.0171	0.01113	0.00421	0.0069	0.0274	0.00	0.03
Dagala,Saleem,Wadshantoor	18	0.0328	0.00461	0.00109	0.0305	0.0351	0.03	0.04
Khartoum	20	0.0465	0.00813	0.00182	0.0427	0.0503	0.04	0.07
Total	50	0.0340	0.01471	0.00208	0.0298	0.0382	0.00	0.07

Table 4 : Multiple comparison of lead concentration in drinking water between studied groups

Multiple Comparisons

Dependent Variable: pbconc
Tukey HSD

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Blue Nile	Arbagi	-.00514	.00503	.737	-.0185	.0083
	Dagala	-.02022*	.00434	.000	-.0318	-.0087
	Khartoum	-.03450*	.00429	.000	-.0459	-.0231
Arbagi	Blue Nile	.00514	.00503	.737	-.0083	.0185
	Dagala	-.01508*	.00382	.001	-.0253	-.0049
	Khartoum	-.02936*	.00377	.000	-.0394	-.0193
Dagala	Blue Nile	.02022*	.00434	.000	.0087	.0318
	Arbagi	.01508*	.00382	.001	.0049	.0253
	Khartoum	-.01428*	.00279	.000	-.0217	-.0068
Khartoum	Blue Nile	.03450*	.00429	.000	.0231	.0459
	Arbagi	.02936*	.00377	.000	.0193	.0394
	Dagala	.01428*	.00279	.000	.0068	.0217

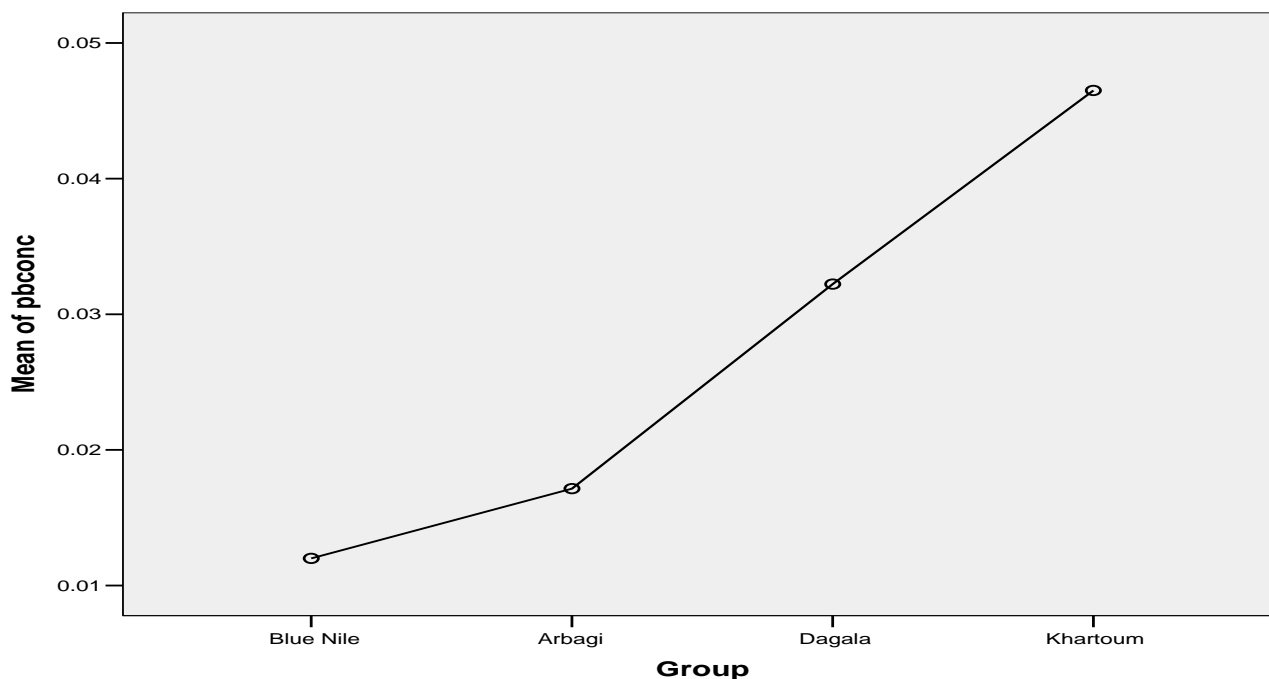*. The mean difference is significant at the .05 level.

Figure 1 : Means of Pb- concentration in the studied groups

Table (2) Summarize data on lead content in drinking water by the atomic absorption method of the studied samples.The concentration of lead was ranged between 0.00-0.07 ppm. The highest concentration of lead(0.07ppm) was found in Khartoum samples and the lowest concentration(0.00ppm) was found in samples of the Blue Nile and Arbagi.Three of the studied samples have zero value. The mean concentration of lead in drinking water by the atomic absorption method was 0.034ppm which was less than the amount allowed by the WHO.

Table(4) shows a multiple comparison of concentration of lead in drinking water between the studied groups.The mean difference was significant at the 0.05 level.

Samples from the Blue Nile was done to make a comparison between the concentration of lead in drinking water before transfer via pipes and after that and this is because most of lead may enter to water should be come from the soldering materials of this pipes. The mean concentration of lead in drinking water of the Blue Nile samples (0.0120ppm) was the lowest value among all other means which prove that much amounts of lead content in water should be come from pipesas expected . Also the results show that the minimum concentration of lead in theBlue Nile samples was 0.00 ppm and the highest concentration of lead in these Samples was 0.03ppm and this concentration was so high with respect to other samples and this is because a lot of lead come to the river from soil and air and from pollutants which were throwed in the river. Samples which were collected from Arbagi where houses that water provided by plastic pipes showed

also low concentrations of lead(average concentration of 0.0171ppm) the lowest concentration in Arbagi samples was 0.00ppm and the highest concentration was 0.03 ppm. The mean concentration of lead in samles from Arbagi(0.017ppm) and samples from the Blue Nile(0.012ppm) were very nearer to each other and that is because there is no soldering materials in pipes that delivered drinking water in Arbagi. Samplesfrom Wadshantoor, Dagala, Saleem where water delivered by metallic pipes have an average value of (0.0322ppm), the lowest lead concentration was 0.03ppm and the highest lead concentration in these villages was 0.04ppm and this is because a lot of lead comes from soldering materials in these metallic pipes. Samples from Khartoum have the mean value (0.0465ppm) which is the highest lead concentration and this is shows that the concentration of lead in drinking water samples of Khartoum were greater than that of the rural areas and this is because that many industries were found in Khartoum and ahuge quantities of industrial wasted which may contain a high concentration of lead should be found there. Also Khartoum was so traffic crowded so the soil and the air of Khartoum would be very contaminated with lead than other rural areas which may affect the concentration of lead in drinking water positively.

The concentration of lead in drinkingwater allowed by the WHO (0.05 ppm) exceeded by only two samples of Khartoum samples (0.07ppm), and (0.06ppm). All other samples of drinking water in the present study were less than the amount allowed by the WHO.

Lead in water may comes from pipe solder, soil, air, and all other environmental pollution,but much lead may come from metal pipes so the concerned authority should try to use plastic pipes in providing drinking water, or use other soldering materials instead of lead.

The mean concentration oflead in water to some extent was not so dangerous (0.034ppm) with respect to the concentration that allowed by the WHO which was 0.05ppm and also the same concentration was allowed by EEC and the USEPA.

Results from this table indicated that there was no significant difference in the concentration of lead in drinking water between the samples that collected from the Blue Nile and the concentration of lead in drinking water of Arbagi where water provided by plastic pipes (sig. 0.737) which means that plastic pipes showed less contamination with lead. Samples of drinking water collected from Dagala, Saleem, and Wadshantoor where water was provided by metallic pipes showed significant difference to that of the Blue Nile (sig.0.00).

Significant difference between the concentration of lead in the drinking water of Arbagi where water provided by plastic pipes and the concentration of lead in drinking water of Dagala, Saleem, and Wadshantour was found (sig.0.001).

The concentration of lead in drinking water from Khartoum showed significant differences to samples collected from all other areas (sig. 0.000)

Fig.(1) presents the range of concentrations of lead in drinking water in the areas under study. And it shows increasing order in the concentration of lead from the Blue Nile, Arbagi, Dagala, and Khartoum.

IV. Conclusion

Atomic Absorption spectrometry method is economical, fairly selective, precise, and more sensitive. The method is free from interferences which is an advantage of this method. Therefore the method can be used for routine analysis of water.

Although children are at greater risk from lead exposure, adult exposures can also result in harmful health effects. Most adult exposures are occupational and occur in lead-related industries such as lead smelting, refining, and manufacturing industries. One frequent source of lead exposure to adults is home renovation that involves scraping, remodeling, or otherwise disturbing lead-based paint. Adults can also be exposed during certain hobbies and activities where lead is used. Workers may inhale lead dust and lead oxide fumes, as well as eat, drink, and smoke in or near contaminated areas.

It should be noticed that all types of contamination may affect each other that means lead from soil may come into water; also lead from air may come into soil, and lead from paint and batteries industry may come into water, soil and air and so on.

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