Heavy metal contamination of drinking water in the city of Baiji

Sami. A. Zbaar
Department of biochemistry,
College of medicine ,
Tikrit University.

Shaker m. Marbut
University College of Madinat Al-elem,
Baghdad,
Iraq.

Abstract

In order to ascertain water quality for human consumption and determined the sources of contamination, heavy metal were evaluated in the drinking water supplies to the city of Baji and its surrounding villages in Iraq. Standard methods were used for determining the concentration of heavy metals include Pb , Cd, Cu, and Zn in drinking water samples by atomic absorption spectrophotometer supplied with a carbon rode atomizer to increase the sensitivity. The results showed that the amount of lead present in the drinking water is high and ranges from 0.06± 0.03 to 0.14± 0.02 ppm , cadmium value were from the below detection limit to 0.01 ppm, copper value were ranges from 0.21± 0.08 to 0.58± 0.04 and zinc value were ranges from 1.57 ±0.37 to 2.30±o.45. to investigate the sources of contamination a samples from waste water of Baiji refineries and Baji power station have been taken to measures Pb , Cd, Cu, and Zn contents. No correlations were found between metal concentrations in the drinking water samples. This means that the contamination might come from corrosion of the pipes line system

Keywords: heavy metal ions, drinking waters , water contamination

تلوث مياه الشرب بالعناصر الثقيلة في مدينة بيجي

سامي زبار

قسم الكيمياء الحياتية/

كلية الطب/جامعة تكريت

شاكر محمود مربط

كلية مدينة العلم الجامعة/

بغداد – العراق

الخلاصة

لكي نتحقق من نوعية الماء الصالحة للاستهلاك الإنساني ، وإيجاد مصادر التلوث بالمعادن الثقيلة، تم تقييم الماء المجهز للشرب في مدينة بيجي والقرى المحيطة بها، وقد استخدمت الطرق القياسية لتقرير تركيز المعادن الثقيلة والتي تتضمن : الرصاص، الكادميوم، النحاس والزنك في عينات الماء الصالح للشرب باستخدام تقنية الامتصاص الذري Spectrophotometer مجهز بقطب كربون لزيادة الحساسية ، وقد أظهرت الفحوصات النتائج التالية:

- كمية الرصاص بمجاميع تتراوح من $(0.06 \longrightarrow 0.14)\ PPm$
- قيمة الكادميوم تراوحت من تحت حد الكشف إلى $0.01\ PPm$
- قيمة النحاس تراوحت مابين $(0.21 \longrightarrow 0.58)\ PPm$
- قيمة الخارصين كانت مجاميع من $(0.37 \longrightarrow 1.57)\ PPm$

لتحري مصادر التلوث أخذت عينات من مياه الصرف الصحي ومن تبريد مصافي بيجي وتبريد محطة الطاقة الكهربائية في بيجي وتم قياس تراكيز الرصاص، الكادميوم والنحاس فيها ولم تثبت أية علاقة ما بينها وبين المياه المجهزة للمدينة وهذا يؤيد بأن العناصر الثقيلة الموجودة في مياه الشرب قد يكون سببها تآكل شبكة المياه.

Introduction:

The presence of toxic metals in human body is dangerous causing serious health problems through interfering with normal biological function.

Some heavy metals have been reported to be of bio-importance to human and others like As, Cd, Pb, and methylated forms of Hg have been reported to have no known biological function in human and consumption even at very low concentrations can be toxic [1].

The widespread of contamination with heavy metal in the last decades has raised public and scientific interest due to their dangerous effects on human health This has led researchers to study the pollution with heavy metal in water and to determine their permissibility for human consumption.

The term heavy metal refers to any metallic chemical element that has a relatively high density and is toxic or poisonous at low concentrations. Heavy metals include lead, cadmium, cobalt, zinc, arsenic, mercury, silver, chromium, copper, iron, and platinum.[2].

Heavy metals concentration in the water cannot be attributed to geological factors alone, but human activities do modify considerably the mineral composition of water. The recent population and industrial growth has led to increasing production of domestic, municipal and industrial wastes. Heavy metals are natural components and cannot be degraded or destroyed. to a small extent, they enter our bodies via food, drinking water and air[3].

Along with many other toxic compounds in the environment, a lot of heavy metals, or the metals with a very high density, are present in our immediate environment. These heavy metals may contaminate water supplies, the natural water analysis for physical, chemical properties including trace element contents are very important for public health studies [4].

The biotoxic effects of heavy metals refer to the harmful effects of heavy metals to the body when consumed above the bio-recommended limits. Heavy metals disrupt metabolic function in two basic ways:

- First, they accumulate and thereby disrupt function in vital organs and glands such as the heart, brain, kidneys, bone and liver.
- Second, they displace vital nutritional minerals from where they should be in the

body to provide biological function [5].

Individual metals exhibit specific signs of their toxicity, the following have been reported as general signs associated with lead, cadmium, arsenic, and zinc poisoning.

Lead is the most significant toxin and if released into the environment can bio accumulate and enter the food chain. At relatively low levels of exposure, these effects may include interference in red blood cell chemistry, and it interferes with normal cellular metabolism. Lead has damaging effects on body nervous system. acute and chronic damage to the central nervous system (CNS) and peripheral nervous system (PNS) .Lead affects children by leading to the poor development of the grey matter of the brain,

Materials that contain lead have frequently been used in the construction of water supply distribution systems and plumbing systems in private homes and other buildings. The most commonly found materials include service lines, pipes, brass, bronze fixtures, solders and fluxes. Lead in these materials can contaminate drinking water as a result of the corrosion that takes place when water comes into contact with those materials [6].

Cadmium, a metal, is found naturally in very low concentrations in most rocks, as well as in coal and petroleum and often in combination with zinc. Cadmium uses include electroplating, nickel-cadmium batteries, paint and pigments, and plastic stabilizers. It is introduced into the environment from mining and smelting operations and industrial operations, including electroplating, reprocessing cadmium scrap, and incineration of cadmium-containing plastics. Cadmium may enter drinking water as a result of corrosion of galvanized pipe [7].

Cadmium is toxic at extremely low levels. In humans, long term exposure results in renal dysfunction, characterized by tubular proteinuria. The kidney is considered to be the critical target organ in humans chronically exposed to cadmium by ingestion.

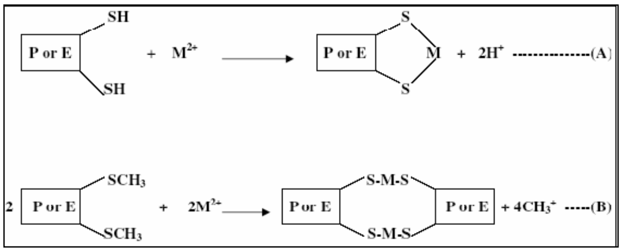
High exposure can lead to obstructive lung disease, cadmium pneumonitis, resulting from inhaled dusts and fumes. Cadmium is also associated with bone defects, osteomalacia, osteoporosis and spontaneous fractures, increased blood pressure and myocardic dysfunctions[8].

Copper, a reddish-brown metal, is often used in plumbing of residential and commercial structures that are connected to water distribution systems. Copper contaminating drinking water as a corrosion by-product occurs as the result of the corrosion of copper pipes that remain in contact with water for a prolonged period. Copper is an essential nutrient, but at high doses has been shown to cause stomach and intestinal distress, liver and kidney damage, and anemia [9].

Zinc is considered to be relatively non-toxic, especially if taken orally. Excess amount can cause system dysfunctions that result in impairment of growth and reproduction The clinical signs of zinc toxicities have been reported as vomiting, diarrhea [10].

Heavy metal poisoning:

The poisoning effects of heavy metals are due to their interference with the normal metabolic processes, in the acid medium of the stomach, they are converted to their stable oxidation states (Zn2+, Pb2+, Cd2+,Cu2+) and combine with the molecules such as proteins and enzymes to form strong and stable chemical bonds. The equations below show their reactions during bond formation with the sulphydryl groups of cysteine -SH and sulphur atoms of methionine –SCH_3[11].



Where: P = protein; E = Enzyme; M = Metal

The hydrogen atoms or the metal groups are replaced by the poisoning metal and the enzyme is thus inhibited from functioning, whereas the protein–metal compound acts as a substrate and reacts with a metabolic enzyme. [12]. the deleterious effects of heavy metal ions have been attributed to their interactions with specific, particularly susceptible native proteins. Proved to inhibit very efficiently the spontaneous refolding of chemically denatured proteins by forming high-affinity complexes with thiol and other functional groups.

Therefore, the metal remains embedded in the tissue as metallo-enzyme and can be conveniently replaced by another metal ion of similar size. Thus Cd2+ can replace Zn2+ in some dehydrogenating enzymes, leading to cadmium toxicity [13].

The most toxic forms of these metals in their ionic species are the most stable oxidation states as will as heavy metals in the body multiply free radicals chain reactions several thousands, free radicals process contribute to the uncontrolled chain reaction causes several damages within the cells[14].

Material and method:

Prior to analysis all instruments were calibrated according to manufacturer's recommendation

The drinking and waste water samples were collected in pre-washed (with detergent, doubly de-ionized distilled water, diluted HNO_3 and doubly de-ionized distilled water, respectively) polyethylene bottles from 5 drinking water stations in bajii, waste water of Baiji refineries, Baiji power station are taken in Dec. 2007.

One liter of each water sample was taken in duplicate at two deferent sampling periods approximately one month a part. the drinking water sample were obtained directly from the water pump after allowing the water to run at least 20 minutes while waste water samples were obtained from waste water pools [15].. These samples were analyzed by flameless atomic absorption spectrometry (Spectroil M Analysis Spectrometer) in triplicate to determine lead, cadmium, zinc and copper. Table (1) showed wave lengths that used to measure the concentration of these metals. A standard solution for each element under investigation was prepared and used for calibration [16].standards and samples are in disposable plastic sample holders and it is important that the sample holder be filled level with the top. The bottom of the disc electrode should be immersed in the sample before analysis [17]..

Result:

The results of heavy metal contents in drinking water are shown in Table 2. The results showed that all drinking water samples have higher concentration of lead than that recommended by WHO 1984.

.where it ranges: 0.06± 0.03, 0.14± 0.02 in station no. 4 and 2 respectively. The concentration of lead in waste water is too high ranges: 0.76 in refinery and 0.64 in power station.

As shown in Table 2, the concentrations of cadmium of all drinking water samples under investigation were under the maximum permissible concentration of cadmium (FAO/WHO 1984). While the cadmium concentrations in waste water were 0.07 in refinery and 0.03 in power stations.

This study show that the zinc content in water samples less than the maximum limit allowed of zinc for drinking water. It was range of 1.57± 0.37 to 2.30 ppm, the lowest and highest values were in station 1 and 3 respectively. Also there is some variation between stations. Zinc concentrations in waste water were 8.3 in refinery and 5.8 in power station.

Copper concentrations in the drinking water samples were in the range of 0.21± 0.08 , 0.58± 0.04 ppm. The lowest and highest values were in station 4 and 5 respectively, but even in Station 5 Cu was considerably below the limit of 1.0 mg/1 permitted by WHO in drinking water. Waste water contained of copper was 1.2 in refinery and 1.8 in power station.

Discussion:

The data obtained from the study recalled that drinking water have a high level of lead than that permitted by WHO. The study is in disagreement with Soylak (2002) who was found that the lead level in Tigris river below the permissible limit given by WHO.

This study showed that the river contamination occur in Iraqi area might be due to release a large amount of petrol due to several explosions of main pipe line close to the city of Baji, also our study showed that the waste product of Baji refineries and Baji power station which release directly to the river stream have a high level of lead as shown in table 3 in addition to that some station still using lead pipe which increase the level of lead in drinking water, lead can be found in the solder used to join copper pipes, and a major source of environmental Pb, particularly in urban areas, is due to the combustion of leaded petrol. Lead is discharged by vehicles into air, and then adsorbed from the air by environmental samples such as soil and plant than inter the water ways from soil. The cadmium was blow the normal level in this study.

The study showed that the zinc level in drinking water samples were with in normal in spite of the presence with high amount in waste water of Baiji refinery and power station.

The study showed that the concentration of copper with in normal except that of waste water which are above normal.

Our study is in disagreement with Kalid (2006) who found that the lead level in the Salamani drinking water below the accepted internationality level. Further studies are recommended to study the sources of contamination of the drinking water with heavy metal and investigate other sources of contamination

Although heavy metals cannot be avoided due to their prevalence in the environment, several measures besides avoidance of the source of heavy metals can be taken to treat toxicity.

Diet, nutritional supplements and chelating agents such as DMSA are safe and effective means to reduce heavy metal toxicity. No correlations were found between metal concentrations in the drinking water samples.

References:

1. Nolan K .Copper Toxicity Syndrome. J. Orthomol. Psychiatry. 2003; 12(4): 270 – 282.
2. Young RA .Toxicity Profiles: Toxicity Summary for Cadmium. Risk Assessment Information System, RAIS, University of Tennessee. 2005.
3. Kantor D .Guillain-Barre Syndrome, The Medical Encyclopedia. National Library of Medicine and National Institute of Health. 2006.
4. Oehme, FW. Toxicity of heavy metal in the environment. Marcel Dakker, Inc. New York. Part 1,1 1989.
5. Lenntech Water Treatment and Air Purification. Water Treatment. Published by Lenntech, Rotterdamseweg, Netherlands. 2004.
6. Bakarji.E.H, Krajo. J. Determination of heavy metals in Damascus drinking water using total reflection X-ray fluorescence, Water Quality Research J. Canada. 1999: 34**,** 305.
7. Pip E.. Copper, lead, and cadmium concentrations in a sample of lake Winnipeg Anodonta grandis. The Nautilus 1990; 103: 140-142.
8. Institute of Environmental Conservation and Research INECAR (2000).
9. Ogwuegbu MOC, Muhanga W .Investigation of Lead Concentration in the Blood of People in the Copper belt Province of Zambia,J. Environ. 2005; (1): 66 – 75.
10. National Institute of Neurological Disorders and Stroke, NINDS. Guillain-Barre Syndrome, Guillain-Barre Syndrome Fact Sheet. 2007.
11. Ogwuegbu MO, Ijioma MA .Effects Of Certain Heavy Metals On the Population Due To Mineral Exploitation. In: International Conference on Scientific and Environmental Issues. In the Population, Environment and Sustainable Development in Nigeria, University of Ado Ekiti, Ekiti State, Nigerian. 2003; 8-10.
12. Holum JR .Elements of General and Biological Chemistry, 6th Edition, John Wiley and Sons, N.Y. (1983). pp. 324, 326, 353, 469.
13. Ferner DJ .Toxicity, heavy metals. E. Med. J. 2001; 2(5): 1.
14. Takayuki Ozawa in Understanding the Process of Aging, edited by Enrique Cadenas and Lester Packer (Marcel Dekker, New York. 1999; 265-292.
15. 15- Amman,A.A.; Michalke,B.; Schramel, P.Speciation of heavy metals in environmental water by ion chromatography coupled to ICP-MS. Anal. Biochem.,(2002).372,448-452.
16. Kalid. M. Omer. Solid phase preconcentration technique for the determination of lead in water. KAJ. Kurdistan Academicians journal. 2006 4(1)part A (147-152)

Soylak.M, Armagan. F, Saracoglu. Setal. chemical analysis of drinking water samples from Yozgat Turkey. Polish journal of environmental studies Vol.11, No 2(2002)151-256.

Table 1. heavy metal contents n drinking water by the World Health Organization
(WHO) and Wavelength of absorption in atomic absorption spectrophotometer.

Heavy metal	Max. acceptable conc. (WHO)	Wavelength (nm)
Lead	0.01 mg/L	283
Cadmium	0.003 mg/L	228
Zinc	5.0 mg/L	213
copper	1.0 mg/L	324

Table 2. concentration of heavy metal in different water samples.

Station no. (Drinking water)	Lead (Pd) mg/L	Cadmium (Cd) mg/L	Zinc (Zn) mg/L	Copper (Cu) mg/L
Station 1	0.12 ± 0.04	0.01	1.57 ± 0.37	0.38 ± 0.09
Station 2	0.14 ± 0.02	0.00	1.80 ± 0.21	0.32 ± 0.12
Staton 3	0.08 ± 0.02	0.00	2.30 ± 0.45	0.43 ± 0.9
Station 4	0.06 ± 0.03	0.01	2.10 ± 0.18	0.21 ± 0.08
Station 5	0.13 ± 0.06	0.00	1.65 ± 0.32	0.58 ± 0.04

Table 3. concentration of heavy metal in waste water samples.

Waste water	Lead (Pd) mg/L	Cadmium (Cd) mg/L	Zinc (Zn) mg/L	Copper Cu) mg/L
Baiji refineries	0.76 ± 0.12	0.07 ± 0.02	8.3 ± 2.4	1.2 ± 0.1
Baiji power station	0.64 ± 0.08	0.03 ± 0.01	5.8 ± 0.8	1.8 ± 0.3