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Determination of Iron, Copper, Lead and Cadmium Concentrations in Rain Water Tanks in Misurata, Libya

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ABSTRACT

Rain water samples were collected from four tanks presented in four areas of Misurata, Libya. All the samples were analyzed for four physicochemical parameters such as temperature, conductivity, total dissolved solids (TDS) and pH, and four heavy metals, viz., Fe, Cu, Pb and Cd using standard procedures. The data showed the variation of the investigated parameters in rain water samples as follows: temperature 25.01-27.65ºC, pH 7.87 - 8.54, conductivity (EC) 397.5 - 843.75 µsimens/cm^3, total dissolved solid (TDS) 258.4 - 548.4 mg/l. The ranges of concentration of Fe and Cu in rain water (µg/L) were and 17-82 and 2.8-13.9, respectively. The investigated parameters and concentration of heavy metals in the rain water samples from Misurata were within the permissible limits of the World Health Organization drinking water quality guidelines.

Keywords: *Rain water, parameters, conductivity, heavy metal*.

1. INTRODUCTION

Rainwater is usually considered a safe and suitable source of potable water, and it is commonly used as such, especially in rural areas in developing countries of the world. Rainwater harvesting is a technology used for collecting and storing rainwater from rooftops, the land surfaces, steep slopes, road surfaces or rock catchments using simple techniques such as pots, tanks and cisterns as well as more complex techniques such as underground check dams. (Appan, 1999; Makoto, 1999; Prinz, 1999). Nowadays, commonly used systems are constructed of three principal components; namely, the catchment area, the collection device, and the conveyance system. Additionally, leaf screens and roof washers are often used by householders to remove contaminants and debris (GDRC, 2002; TWDB, 1997).

Harvested rainwater can then be used for rainfed agriculture or water supply for households. Unfortunately, rainwater might be polluted by bacteria and hazardous chemicals requiring treatment before usage. Slow sand filtration and solar technology are methods to reduce the pollution. Membrane technology would also be a potential disinfection technique for a safe drinking water supply.

Iron and copper are essential bioelements which, in addition to their biological role and their importance for the development of the human body, also have a toxic effect when found in amounts higher than normal in the human body. Lead and cadmium are highly toxic metals, even when found only in traces (Goyer, 1997; Goyer et al, 1995).

Iron is very essential for most living things. It is a component of hemoglobin, myoglobin as well as a number of enzymes such as cytochrome oxidizes, xanthenes oxidize, peroxides and catalane (Lynch et al, 1996).
Iron toxicity occurs when there is free iron in the cell, which generally occurs when iron levels exceed the capacity of transferring to bind the iron. Free iron reacts with peroxides to produce free radicals, which are highly Reactive and can damage DNA, proteins, lipids, and other cellular components.

Copper is one of the essential bimetals necessary for the growth, development and normal functioning of the human body, for the synthesis of hemoglobin, melanin, and the mineralization and development of bones. The lack of copper can lead to serious illnesses (Uauy, et al., 1998; Hart, et al. 1928; Chapman, 2008). It also promotes iron absorption from the gastrointestinal system, is involved in the transport of iron from tissues into plasma, helps to maintain myelin in the nervous system, is important in the formation of bone and brain tissues and is necessary for other many important functions (Freemantle, 1989; Khalifa et al, 2001). Excess copper in the human body can cause stomach and intestinal distress such as nausea, vomiting, diarrhea, and stomach cramps (Orhan et al, 2005)

Lead is a toxic metal with a cumulative effect, which competes with the essential metals in the human body (Ca, Fe, Cu, and Zn). A relatively low content of lead has a negative effect on the heart, blood vessels, kidneys, liver, and respiratory system. Based on its physical chemical characteristics, BP (II)- ions can replace Ca (II) - ions isomorphic ally as part of hydroxyapatite, which leads to the accumulation of this

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metal in mineral tissue – the teeth and bones. During physiological processes of bone tissue remodeling, part of the Pb (II)- ions, by migration through the oral and other biological fluids, reach other remote organs – the brain, kidneys, and the liver (Pocock et al., 1994; Banks et al., 1997; Vig et al., 2000).

Cadmium is a toxic and carcinogenic metal. The primary sources of cadmium exposure are cigarette smoke, food intake (shellfish, offal and certain vegetables), and ambient air, particularly in urban areas and in the vicinity of industrial settings, (Zhang et al., 2009).

Due to the harmful and toxic effects of iron, copper, lead and cadmium, it is necessary to determine and monitor their content in water. Recently, several methods of analysis were done for determination of heavy metals in rain water samples, e.g., by voltammetry (Mamdouh et al, 2002; Hendrik,2000) and atomic absorption spectroscopy (Amina, 1999; Farahmandkia et al,2010;Sekabira et al,2010; Kanellopoulou,2001; Jitendra et al, 2012).

2. EXPERIMENTAL

2.1 Collection and Sampling of Raw Rain water

The sixteen rain water samples are collected in October 2010 and from four rain water tanks, two samples are collected from the top and two from the bottom of each tank, are presented in four areas, viz, Abbad, Al-Jazirah, Qasr Ahmad and Zawyet-El-Mahgoub in Misurata city, northwestern Libya. The rainwater tanks were constructed from concrete. After collection, rain water samples were transferred without any treatment into clean 2-L polyethylene bottles, tightly covered by caps, and then stored in a dark, cool place in the laboratory. This storage can minimize any water quality change by evaporation or processes by biological activity. Immediately after collection, the temperature, pH and conductivity of rain water samples were measured.

2.2 Sample Analysis

Physical parameters like temperature, pH and conductivity of the samples were measured at the sampling sites using appropriate apparatus. The determinations of heavy metals (Fe, Cu, Pb and Cd) were done through Atomic Absorption Spectrometry.

3. RESULTS AND DISCUSSION

3.1 Physical and Chemical Properties of the Samples

The average results of each four sample collected from each tank of physical and chemical properties of the water samples including temperature, pH, electrical conductivity and total dissolved salts from Misurata, Libya were given in Table 1.

a. Temperature

The temperature values were in the range of 25.01-27.65ºC (lowest in Qasr Ahmad, highest in Al-Jazirah).

b. **pH**

It was observed from the pH value that water samples were varying from 7.87 to 8.54 and these values are within the limits prescribed by ICMR:1975 (7-8.5) and WHO: 2003 (6.5-9.5) (Tatawat et al,2008).

c. **Electrical Conductivity (EC)**

EC of the rain water is varying from 397.5 to 843.75 microsiemens/cm^3 at 25°C .the maximum limit of EC in drinking water is prescribed as 1400 microsiemens/cm^3 (WHO:2003) (Tatawat et al,2008).

d. **Total Dissolving Solids (TDS)**

The total dissolved solids in rain water are represented by the weight of residue left when a water sample has been evaporated to dryness. TDS values varied from 258.4 to 548.4 mg/l. The permissible limit prescribed by WHO: 2003 (500 mg/l) and ICMR: 1975 (600 mg/l) (Tatawat et al, 2008).

Table1: Physico-chemical parameters of rain water of Misurata city

Sampling location	T ºC	pH	EC µS/cm^3	TDS mg/l
Abbad	27.1	8	843.75	548.4
Al-Jazirah	27.65	8.54	826.25	537.1
Qasr Ahmad	25.01	7.87	471.25	306.3
Zawyet-El-Mahgoub	26.64	7.99	397.5	258.4

3.2 Heavy Metals

The concentrations of heavy metals (Fe, Cu, Pb and Cd in the rain water samples are presented in Table 2. Levels of iron and copper were above the detection limit in all the samples. Lead and cadmium were below the detection limit in all of the samples.

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Table 2: Concentration of heavy metals, Fe, Cu, Pb and Cd (µg/L) in rain water samples from Misurata city.

Sampling location	Fe, µg/l	Cu, µg/l	Pb	Cd
	$\bar{x}$±SD	$\bar{x}$±SD		
Abbad	53±2.6	4.2±0.20	BDL	BDL
Al-Jazirah	63±3	13.9±0.80	BDL	BDL
Qasr Ahmad	82±2.1	4.2±0.50	BDL	BDL
Zawyet-El-Mahgoub	17±0.5	2.8±0.12	BDL	BDL

BDL= below detection limit of the method.

In the areas studied, iron content varies from 17 µg/L in sample taken from Zawyet-El-Mahgoub to 82 µg/L from Qasr Ahmad. All of the samples comply the desirable concentration of iron in drinking water (300µg/L) set by WHO (2008) (Gebrekidan, 2011).

In this study, a minimum of 2.8 µg/L and maximum of 13.9 µg/L copper concentration were recorded in rain water samples from Zawyet-El-Mahgoub and Al-Jazirah

Respectively. All of the samples below the desirable concentration of iron in drinking water (2000µg/L) set by WHO (2008) (Gebrekidan,2011).
In this research, lead and cadmium are the metal that were not detected in all the sampling areas presumably due to the low lead and cadmium related industrial and mining activities in the sampling areas.

4. CONCLUSION

The investigated Physical and Chemical Properties (pH, EC and TDS) and the concentrations of the heavy metal ions (Fe, Cu, Pb and Cd) in the rain water samples from Misurata /Libya were found below the guidelines for drinking waters given by the World Health Organization (WHO) and the Indian Council of Medical Research (ICMR) (Tatawat et al,2008;Gebrekidan,2011).)., making the rain water suitable for drinking and recreational purposes..

REFERENCES

[1] Amina, L. R. S., Chakrabarti, C.L., Back, M.H., Grégoire, D.C., Lu, J. Y. and Schroeder, W.H.(1999): Stability of dissolved metals in environmental aqueous samples: Rideau River surface water, rain and snow, Analytica Chimica Acta 402 : 223–231.

[2] Appan, A. (1999): Economic and water quality aspects of rainwater catchment system, Proceedings of International Symposium on Efficient Water Use in Urban Areas, UNEP Int. Environ. Tech. Center, Osaka, Japan, pp. 79

[3] Banks, E.C., Ferretti, L.E. and Shucard, D.W. (1997): Effects of low level lead exposure on cognitive function in children: a review of behavioral, neuropsychological and biological evidence. Neurotoxicology 18:237-281.

[4] Chapman, T.L. (2008): Genetic Heavy Metal Toxicity: Explaining SIDS, Autism, Tourette's, Alzheimer's and Other Epidemics, Universe Inc. Lincoln, pp. 1-119.

[5] Farahmandkia, Z., Mehrasbi, M. R. and Sekhavatjou, M. S. (2010): Relationship between concentration of heavy metals in wet precipitation and atmospherica PM_{10} particles in Zanjan, Iran. Iran. J. Environ. Health. Sci. Eng. 8(1): 49-56.

[6] Freemantle, M.H.(1989): Chemistry in Action, Macmillan Education Ltd., London.

[7] GDRC. (2002): An Introduction to Rainwater Harvesting General Description, The Global Development Research Center, Osaka, Japan.

[8] Gebrekidan, M. and Samuel, Z.(2011): Concentration of heavy metals in drinking water from urban areas of the Tigray region, northern Ethiopia. Momona Ethiopian Journal of Science 3 (1):105-121.

[9] Goyer, R.A. (1997): Toxic and essential metal interactions. Annual Review of Nutrition 17: 37-50.

[10] Goyer, R. and Klaassen, C.D. (1995). Metal Toxicology, Academic Press, San Diego, pp. 31-45.

[11] Hart, E.B., Steenbock, H., Waddell, J and Elvehjem, C.A. (1928): Iron nutrition. VII. Copper as a supplement to iron for hemoglobin building in the rat. Journal of Biological Chemistry 77: 797-812.

[12] Hendrik, E., André B. and Michael J. S.(2000): Voltammetric determination of heavy metals in micro volumes of rain water. Electro analysis 12: 1171–1176.

[13] Jitendra, P. and Ashima, S. (2012): Chemical characterization of rain water in a seasonally dry tropical region (Varanasi), India. J. Environ. Biol. 33: 629-634.

[14] Khalifa, M.E., Akl, M.A. and Ghazy, S.E. (2001): Selective flotation-spectrophotometric determination of trace copper (II) in natural waters, human blood and drug samples using phenanthraquinone monophenylthiosemi-Cabazon. Chem. Pharm.Bull. 49: 664-668.

[15] Kanellopoulou, E.A.(2001): Determination of heavy metals in wet deposition of Athens. Global Nest: the Int. J. 3(1): 45-50.

[16] Lynch, S.R. and Baynes, R.D.(1996): Deliberations and evaluation of the approaches, end points and paradigms for iron dietary recommendations. J. Nutr. 126 (Suppl 9): 2404 - 2409.

[17] Mamdouh, E.A., Guy, D. and Salvatore, D.(2002): Calibration less determination of cadmium, lead and copper in rain samples by stripping voltammeter at mercury microelectrodes Effect of natural convection on the deposition step. Analytical Chemical Acta 452:65–75.

[18] Makoto, M.(1999): Creating rainwater utilization based society for sustainable development, Proceedings of the International Symposium on Efficient Water Use in Urban Areas, UNEP Int. Environ. Tech. Center, Osaka, Japan, pp. 107.

[19] Orphan, T. and Mustafa S.(2005): Spectrophotometric determination of Copper in natural waters and pharmaceutical samples with chloro(phenyl) glyoxime. J. of the Chinese Chemical Society 52:575-579.

[20] Pocock, S., Smith, M and Baghurst, P. (1994): Environmental lead and children's intelligence: A systematic review of the epidemiological evidence. British Medical Journal 309:1189–1196.

[21] Prinz, D.(1999): Water harvesting technique in Mediterranean region, Proceedings of the International Seminar Rainwater Harvesting and Management in Arid and Semiarid Areas, Lund University Press, Lund, Sweden, pp. 151.

[22] Sekabira, K., Oryem, O. H., Basamba, T. A.Mutumba, G. and Kakudidi, E.(2010): Heavy metal assessment and water quality values in urban stream and rain water. Int. J. Environ. Sci. Tech. 7 (4):759-770.

[23] Tatawat, R.K. and Chandel, C.P. S. (2008):Quality of ground water of Jaipur City, Rajasthan and its suitability for domestic and irrigation purpose. Applied ecology and environmental research 6(2): 79-88.

[24] TWDB (1997): The Texas Guide to Rainwater Harvesting, 2nd Edition, Texas Water Development Board, Austin, TX.

[25] Uauy, R., Oliveras, M. and Gonzales, M. (1998): Essentiality of copper in humans. American Journal of Clinical Nutrition 67: 952S-959S.

[26] Vig, E.K. and Hu, H. (2000). Lead toxicity in older adults. Journal of the American Geriatrics Society 48: 1501-1506.

[27] Zhang, J., Yequan, F., Jinlong, L., Wang, J., Baoxia, H. and Shiwen, X. (2009): Effects of subchronic cadmium poisoning on DNA methylation in hens. Environmental toxicology and pharmacology 27(3): 345-349.

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تقدير تراكيز الحديد و النحاس و الرصاص و الكادميوم في خزانات مياه الامطار في مصراته ليبيا

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جمعت عينات مياه الامطار من أربعة خزانات منتشرة في أربعة مناطق بمصراته ليبيا. في كل العينات تم تحليل أربعة معاملات فيزيوكيميائية وهى درجة الحرارة و التوصيلية الكهربية و الأملاح الكلية المذابة و الرقم الهيدروجيني وكذا تم تقدير أربعة عناصر ثقيلة و هي الحديد و النحاس و الرصاص و الكادميوم مستخدما الطرق القياسية. و النتائج المستخلصة من هذا البحث تعرض حدود المعاملات الفيزيوكيميائية في مياه الامطار وهى كالتالي : درجة الحرارة وتتراوح بين 25.01 إلى 27.65 درجة مئوية ، الرقم الهيدروجيني و يتراوح بين 7.87 إلى 8.54 ، التوصيلية الكهربية وتتراوح بين 397.5 إلى 843.75 ميكرو سيمينز/ مللي والأملاح الكلية المذابة و تتراوح بين 258.4 إلى 548.4 مللي جرام/ لتر. وقد جاء تركيز الحديد و النحاس في مياه الامطار في حدود بين 17 إلى 82 ميكرو جرام/ لتر و بين 2.8 إلى 13.9 ميكرو جرام/ لتر على الترتيب. وقد جاءت حدود المعاملات التي تم الحصول عليها وكذا تركيز العناصر الثقيلة في مياه الامطار بمصراته جميعها في الحدود المسموح بها من منظمة الصحة العالمية.