Recent Research in Science and Technology 2018, 10: 07-10
doi: 10.25081/rrst.2018.10.3370
http://updatepublishing.com/journal/index.php/rrst/

ISSN: 2076-5061

REGULAR ARTICLE

ASSESSMENT OF HEAVY METAL CONCENTRATION IN COCONUT WATER

MD DIDARUL ISLAM*, ASHIQUR RAHAMAN, ABONI AFROSE

Department of Applied Chemistry and Chemical Engineering, University of Dhaka, Bangladesh; Institute of Leather Engineering and Technology, University of Dhaka, Bangladesh

ABSTRACT

This study was based on determining concentration of essential and toxic heavy metal in coconut water available at a local Hazaribagh area in Dhaka, Bangladesh. In this study, fifteen samples and eight heavy metals were analyzed by Atomic Absorption Spectroscopy (AAS) method which was followed by wet ashing digestion method. The concentration obtained in mg/l were in the range of 0.3 to 1.5, 7.77 to 21.2, 0 to 0.71, 0 to 0.9, 0 to 0.2, 0.9 to 17.3, 0.1 to 0.9, 0 to 0.9 and 0 to 0.7 for Fe, Ni, Cu, Cd, Cr, Zn, Pb and Se respectively. From this data it was concluded that any toxic heavy metals like Cd, Cr, Pb and Ni exceed their toxicity level and some essential nutrients were in low concentration in those samples.

Keywords: Nutrients, Minerals, Heavy metal, Coconut water

INTRODUCTION

Heavy metals are metals having densities higher than 5 gml^{-1}, higher atomic and molecular weight than sodium that forms soaps of reaction with fatty acids [1]. There are mainly four major groups of heavy metals [2]. The essential heavy metals like Fe, Zn, Cu are those which are required for healthy and normal growth of humanity, but in control amount, higher amount of those metals becomes highly toxic. On the other side some heavy metals like Cd, Ni, Pb, Cr, Se are highly toxic at their very low concentration [2, 3]. There is some conflict that Mg is heavy metal or not [1].

Magnesium is a cofactor in hundreds of different enzymatic reactions that regulate diverse biochemical processes in the human body, like protein synthesis, muscle and nerve function, blood glucose control as well as blood pressure control. It is essential for the bone structure formation, DNA, RNA and antioxidant glutathione synthesis. Magnesium is also required for energy production, oxidative phosphorylation and glycolysis processes [4, 5]. Magnesium deficiency induces increased neuromuscular excitability, calcium and potassium deficiency, hypertension, high blood pressure, type II diabetes, anxiety, loss of memory, swallowing difficulty, etc. [4, 6]. There are no known harmful health effects in the general public associated with the large range consumption of Mg [5]. The recommended daily consumption of Mg in a human body is ranging from 240 to 420 mg based on age [7]. At the drinking water minimum level of Mg should be 10 mg/l [8].

Iron another essential element mainly required for hemoglobin. And the daily diet intake of iron differs in male and female [9]. Deficiency of iron can lead to many abnormalities like anemia and other metabolic disorders. Similarly, over consumption also causes deleterious effects like hemochromatosis [10]. According to WHO, USEPA and ISI permeable limit of iron in drinking water are 0.1, 0.3 and 0.3 mg/l respectively [9]. So concentration of $Fe^{2+}$and Fe^{3+}should be controlled 0.1 and 0.2 mg/l, respectively in drinking water [11].

Zinc one among the important micro element acquired through the food. In 1982, JECFA proposed a PMTDI for zinc of 1 mg/kg of a healthy body weight. The daily requirement for a healthy adult man is 15-20 mg/day. Though it is an essential element its level in drinking water should be controlled. More than 5 mg/l in water causes a metallic bitter taste and 25-40 mg/l may cause nausea and vomiting [11]. According to WHO, USEPA and ISI permeable limit of zinc in drinking water is 5 mg/l [9].

Copper is very important for living cells of the body. The daily requirement of Cu in the diet is from 2 to 10 mg, as little as 10 mg can have toxic effects headaches, dizziness and hypertension etc. [3, 12-15]. Threshold limit of copper in drinking water according to WHO, USEPA and ISI are 1, 1.3 and 0.05 mg/l respectively [9].

The main sources of selenium petroleum refineries, erosion of natural deposits and different types of mines. Selenium is an extremely essential trace mineral for the human body as it immunity, act as an antioxidant that defends against free radical damage and inflammation,

Received 17 December 2017; Accepted 14 February 2018

*Corresponding Author

Md Didarul Islam

Department of Applied Chemistry and Chemical Engineering, University of Dhaka, Bangladesh; Institute of Leather Engineering and Technology, University of Dhaka, Bangladesh

Email: didarislam1992dh@gmail.com

reduce risk of cancer, autoimmune and thyroid diseases, reduce heart diseases and can help boost fertility [16]. Overdose of selenium will cause serious metabolic problems [17]. So it should be taken in controlled amounts and its daily requirement in the diet is ranging from 40 to 70 mg. Threshold limit of Se in drinking water according to WHO and USEPA are 0.01 and 0.05 mg/l respectively [9].

Cadmium is extremely poisonous and toxic to humans, which can contaminate drinking water. The main sources of Cd are different types of zinc, lead and copper ores. Short term health effects of Cd are nausea, vomiting, diarrhea, muscle cramp, liver injury, sensory disturbances, convulsions, shock and renal failure. Long term effects are kidney, liver, bone and blood damage [13, 18-20]. Maximum permeable limit of Cd in drinking water according to WHO, USEPA and ISI are 0.005, 0.005 and 0.01 mg/l respectively [9, 21, 22].

The main sources are chromium containing rocks and can be redistributed by volcanic eruptions, some come from tanning industries. It is required in small amounts for normal body functions like digesting food, helps to move blood sugar from the bloodstream into the cells. It also use for type 2 diabetes treatment for some peoples, slows the loss of Ca which prevent bone loss in women during menopause. But its high concentration in drinking water may lead to stomach problems and low blood sugar, too much chromium may damage liver, kidney, nervous system and irregular heart rhythm [23]. Maximum permeable limit of Cr in drinking water according to WHO, USEPA and ISI are 0.1, 0.1 and 0.05 mg/l respectively [9].

Nickel and its compounds are mainly used in industrial purposes and due to the increase of industrialization nickel contamination in the environment also increased. Though it has some unknown metabolic function in the human body, but its high level of human health is highly toxic to living organism [24]. Long term inhalation of nickel may damage the respiratory tract and immune system and also responsible for allergic problem . According to WHO and USEPA permeable limit of nickel in drinking water is 0.025 mg/l [25].

Lead is highly toxic metal for the whole ecosystem; there is no safe level of lead exposure. The main route for lead poisoning in drinking water is leaded fuels, batteries and different types of ores. Low to moderate level of exposure results in hearing loss, inhibition of growth, learning disabilities and gastrointestinal disease, occur at blood lead levels of 1 to 1.2 mg/l in adults and 0.8 to 1 mg/l in children. High level of lead contamination in children results convolutions, major neurological damage, organ failure, coma and ultimate death [26-28]. Though lead has no safe limit in drinking water its maximum permeable limit in water according to WHO and ISI are 0.05 and 0.1 mg/l respectively.

Hazaribagh is one of the most industrialized and most polluted areas of Dhaka as well as whole Bangladesh. Most of the industries dispose huge amount of heavy metals which contaminate the total environment of Hazaribagh. This study was carried out to determine the concentration of some essential and highly toxic heavy metals in coconut water, which was collected randomly from different location in Hazaribagh area.

MATERIALS AND METHODS

Sample collection

All of the fifteen coconut samples were collected from different location in the Hazaribagh area in Dhaka in Bangladesh. The location of the sample collected area is 23.7361 °N and 90.3631 °E.

Sample preparation (Digestion method)

Sample preparation, digestion and determination of heavy metals were done as explained previously [29].

RESULTS AND DISCUSSION

In drinking water, magnesium concentration should be higher than 10 mg/l. From the table 1 and graph it was found that the concentration of Mg in those samples ranging from 0.1 to 1.1 mg/l, average concentration was 0.84667 mg/l and maximum concentration was 1.1 mg/l which is much lower than the minimum required level of it.

Table 1: Concentration of different types of metals present in the samples and their permeable limit in mg/l

Sample ID	Mg (mg/l)	Fe (mg/l)	Ni (mg/l)	Cu (mg/l)	Cd (mg/l)	Cr (mg/l)	Zn (mg/l)	Pb (mg/l)	Se (mg/l)
1	1.1	13.55	0.1	0	0	10.1	0.5	0.5	0.1
2	0.7	11.01	0	0.1	0	12.2	0.2	0.6	0.7
3	0.3	12.04	0.2	0.3	0	10.3	0.9	0.3	0
4	0.8	11.07	0	0	0	0.9	0.1	0.1	0.4
5	1.1	10.21	0	0.1	0	7.1	0.4	0	0.3
6	0.9	15.3	0.1	0	0	10.7	0.6	0.3	0.4
7	0.5	21.03	0.4	0.2	0.1	15.9	0.35	0.4	0.7
8	0.7	12.08	0.3	0	0	11.11	0.15	0.3	0.4
9	1.1	8.8	0	0	0	6.4	0.8	0	0.3
10	1.3	9.23	0.1	0.2	0	10.4	0.65	0.1	0.4
11	0.4	7.77	0	0.2	0.2	9.8	0.5	0.9	0.7
12	0.8	15.11	0	0	0	13.1	0.2	0.5	0.3
13	0.73	21.2	0.43	0.9	0	21	0.7	0.24	0.7
14	1.5	8.1	0	0.01	0	17.3	0.13	0.34	0.4
15	0.77	14.4	0.71	0.21	0.13	8.4	0.89	0.71	0.12
Maximum con.	1.1	21.2	0.71	0.9	0.2	17.3	0.9	0.9	0.7
Average con.	0.84667	12.73	0.156	0.148	0.02867	10.98	0.47133	0.35267	0.39467
MCL*	10**	0.3	0.025	1.30	0.005	0.1	5	0.1	0.05

*Maximum Permeable Level; **Minimum requirement

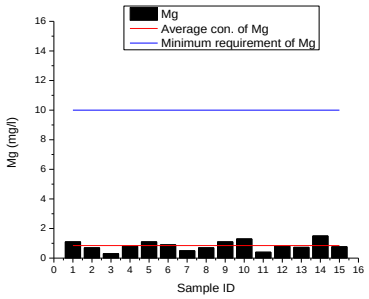

Fig. 1: Concentration of Mg in samples and its average and MCL value

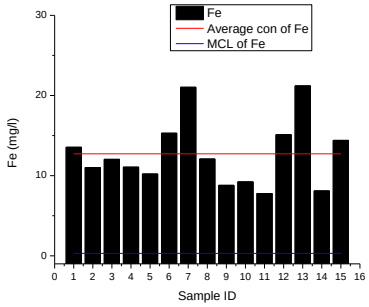

Fig. 2: Concentration of Fe in samples and its average and MCL value

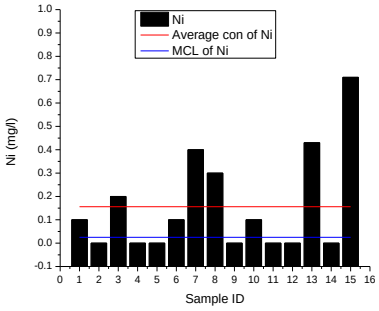

Fig. 3: Concentration of Ni in samples and its average and MCL value

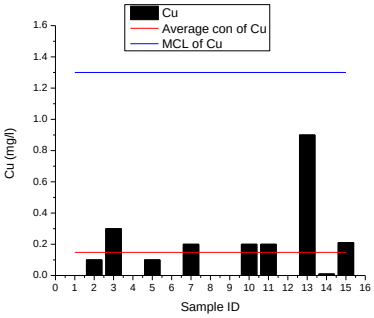

Fig. 4: Concentration of Cu in samples and its average and MCL value

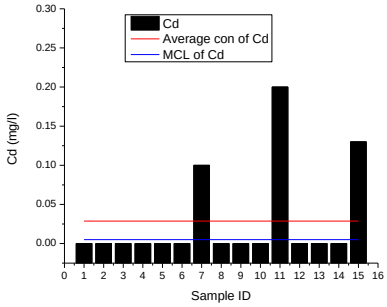

Fig. 5: Concentration of Cd in samples and its average and MCL value

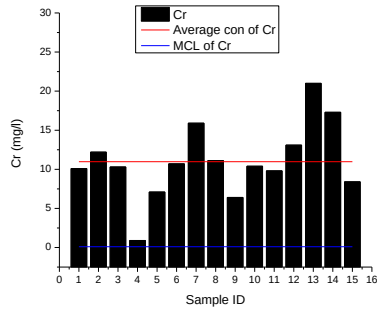

Fig. 6: Concentration of Cr in samples and its average and MCL value

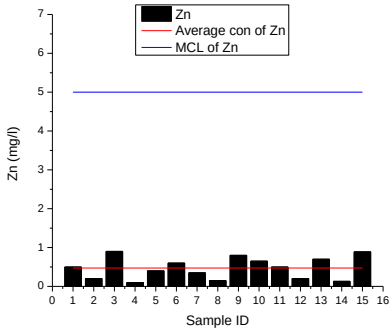

Fig. 7: Concentration of Zn in samples and its average and MCL value

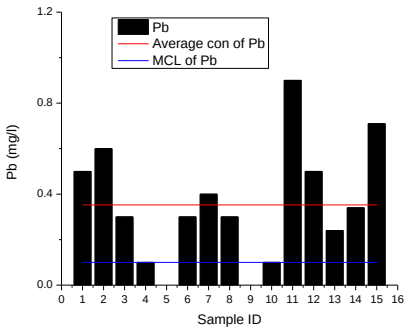

Fig. 8: Concentration of Pb in samples and its average and MCL value

Iron another essential element whose maximum permeable limit in drinking water for $Fe^{2+}$and $Fe^{3+}$are 0.1and 0.2 mg/l respectively. From this graph and table 1 it was found that the concentration of Fe in samples ranging from 7.77 to 21.2 mg/l, average and maximum concentration was 12.72667 and 21.2 mg/l which exceed the MCL. This is because the Hazaribagh area is a highly industrialized area and use huge amounts of iron in different purpose and due to the effluent formed from the industry. Nickel one of the trace elements whose threshold limit in water should be 0.025 mg/l. Here it is found that the nickel concentration ranging from 0 to 0.71 mg/l in different samples and average and maximum concentration was 0.156 and 0.71 mg/l respectively. Some

of the samples (1, 3, 6, 7, 8, 10, 13 and 15) exceed the permeable limit.

In drinking water Cu concentration should be lower than 1.3 mg/l. From the table 1 and graph it was found that concentration of copper in coconut samples ranging from 0 to 0.9 mg/l average and maximum concentration were 0.148 and 0.9 mg/l. All of those values do not exceed the MCL value for Cu in drinking water. From the data table 1 and graph it is found most of the samples does not contain any cadmium (1-6, 8-10, 12-14) sample 7,11 and 15 contain cadmium and exceed the MCL of it.

The Hazaribagh area contains near around 230 tannery industries every of them use chromium for chrome tanning operation and dispose huge amount of untreated Chromium containing effluents which contaminate the local environment. It is natural that all of the drinking water in this area is highly contaminated by chromium. From the graph and date table 1 it was found that all of the samples exceed the maximum permeable limit of chromium in drinking water (0.1 mg). The concentration of chromium in samples ranging from 0.9 to 17.3 mg/l, average and maximum concentration was 10.98067 and 17.3 mg/l respectively. Zinc another essential element for human nutrition, but its concentration in drinking water should be controlled. From the table1 and graph it is found that concentration ranging from 0.1 to 0.9 mg/l which is less than its permeable level in drinking water (5 mg/l).

Lead one of the most toxic element there is no safe level of it. Its level should be minimized for the safe and healthy environment. Table 1 and the graph show that, except 4, 5, 9 and 10 number sample all other exceed the maximum permeable limit (0.1 mg/l) of WHO standard. This due to the highly industrialized area of Hazaribagh. Selenium is an essential trace element for human health, but overdose of it has some adverse effect. From table 1 and graph it is found that all samples contain selenium except 3 and exceed the maximum permeable level of it. From all the data it is clear that all samples contain lower amounts of essential elements, but contain high level of highly toxic Pb, Cr and Fe which are undesirable. For that reason concentration of those heavy metals should be controlled by controlling, heavy metal releasing industries from this area and shifting highly concentrated tannery industry to another area.

CONCLUSION

From the above study it was found that all samples does not exceed the maximum permeable level of minerals but contains lower amounts of essential minerals (Mg, Cu and Zn). Some of the samples contain high concentration of toxic heavy metals (Ni, Cd, Cr, Pb) it is due to the highly contaminated area of Hazaribagh area. Due to reduction of the contamination level from drinking water surrounding local environment should be controlled from contamination. For that reason proper ETP management in industry and lower practice of heavy metal in vehicles can minimize contamination.

REFERENCES

1. Alloway, B. J., *Introduction*, in *Heavy metals in soils*. 2013, Springer. p. 3-9.
2. Sharma, R. K. and M. Agrawal, *Biological effects of heavy metals: an overview*. Journal of environmental Biology, 2005. 26: p. 301-313.
3. Okoye, C., C. Ibeto, and J. Ihedioha, *Assessment of heavy metals in chicken feeds sold in south eastern, Nigeria.* Advances in Applied Science Research, 2011. 2: p. 63-68.
4. Ordinioha, B. and S. Brisibe, *The human health implications of crude oil spills in the Niger delta, Nigeria: An interpretation of published studies.* Nigerian Medical Journal, 2013. 54: p. 10.
5. Organization, W. H., *Nutrients in Drinking Water*. 2005 p. 103-105.
6. Fassa, P., *16 Magnesium Deficiency Symptoms–Signs of Low Magnesium Levels* natural society, transform your health naturally.
7. Heath, N. I. o., *Magnesium Fact Sheet for Health Professionals*.
8. Kozisek, F., *Health risks from drinking demineralised water*. Nutrients in Drinking Water, 2005:p. 148-163.
9. Kumar, M. and A. Puri, *A review of permissible limits of drinking water*. Indian journal of occupational and environmental medicine, 2012. 16: p. 40.
10. Food, I. o. M. and N. Board, *DRI, Dietary Reference Intakes* 2001:National Academy Press.
11. Organization, W. H., *Guidelines for drinking-water quality*. 2011:Geneva: world health organization.
12. Rahman, M. A., I. Rahman, and H. Hasegawa, *Dietary intake of potentially toxic elements from vegetables.* Fruit and vegetable consumption and health, 2009.
13. Okoye, C., *et al.*, *Heavy metals analysis of local and exotic poultry meat*. International Journal of Applied Environmental Sciences, 2011. 6: p. 49-55.
14. Soetan, K., C. Olaiya, and O. Oyewole, *The importance of mineral elements for humans, domestic animals and plants-A review*. African Journal of Food Science, 2010. 4: p. 200-222.
15. *Fitness and Nutrition*. June 17, 2008.
16. Medicine, D. A. F. i., *Selenium Benefits, Signs of Deficiency, and Foods*.
17. cox, L., *What Are Selenium Supplements?* 2014.
18. Organization, W. H., *Cancer pain relief: with a guide to opioid availability*. 1996:World Health Organization.
19. Nkolika, I. C. and O. C. O. Benedict, *Elevated cadmium levels in blood of the urban population in Enugu State Nigeria*. World Applied Sciences Journal, 2009. 7: p. 1255-1262.
20. Health, U. D. o. and H. Services, *Public health service. agency for toxic substances and disease registry.(1995).* Toxicological profile on Silver.
21. Association, W. Q., *WQA Technical Fact Sheet: Cadmium*.
22. Organization, W. H., *Cadmium in Drinking-water* 2011.
23. WebMD, *Chromium-Topic Overview*.
24. Cempel, M. and G. Nikel, *Nickel: a review of its sources and environmental toxicology*. Polish Journal of Environmental Studies, 2006. 15: p. 375-382.
25. Organization, W. H., *Guidelines for drinking-water quality: recommendations*. Vol. 1. 2004:World Health Organization.
26. Mr. Brian Oram, P., *Special Report #3:Lead In Drinking Water-Is There Lead In My Drinking Water ?*
27. Del Toral, M. A., A. Porter, and M. R. Schock, *Detection and evaluation of elevated lead release from service lines: a field study*. Environmental science and technology, 2013. 47: p. 9300-9307.
28. Organization, W. H., *Lead in Drinking-water Background document for development of WHO Guidelines for Drinking-water Quality*. 2011(WHO/SDE/WSH/03.04/09/Rev/1): p. 2-8.
29. Islam MD, Rahaman A, Jannat F. Assessment of micro and macro nutrients in poultry feeds available in Dhaka city, Bangladesh. Journal of Scientific Agriculture. 2017, 1:264-268.