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THE EFFECT OF WATER TREATMENT ON ALUMINUM AND CHROMIUM LEVELS OF WATER IN BOTTLED WATER FACTORIES AND WATER TREATMENT PLANT NO. 2 IN AHVAZ CITY, IRAN

ZAHRA NAZARI KHORASGANI[1,2,] ABDOLGHANI AMERI[3], NAYEREH RANJBAKHSH[4], ABDOLAZIM BEHFAR[3*]

[1]Department of Pharmacology and Toxicology, Pharmacy School, Ahvaz Jundishapur University of Sciences, Ahvaz, IR Iran
[2]Nanotechnology Research Center Pharmacy School, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, IR Iran
[3]Department of Hydrology and food control, Pharmacy School, Ahvaz Jundishapur university of Sciences, Ahvaz, IR Iran
[4]Arvand International Division, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, IR Iran
*Corresponding Author

Abstract

Introduction: Water quality is an important issue for human health management. The aim of this study was to compare aluminum (Al) and chromium (Cr) levels in the water at the inlet to the bottled water factories and water treatment plant NO.2 in Ahvaz city and outlet water of them after the water treatment process. Methods:14 water samples at inlet to each of Byblos and Anahita factories and water treatment plant NO.2 and outlet water of them were collected during 5months(December 2013, January, February, March, April 2014) with 14 times attending there and at each attendance taking 5 1L samples, then mixed and 1L composite sample was isolated, transported to laboratory. The samples were filtered through filter paper (0.45 µm) and for their fixation and protection, the pH were adjusted ≤2 by concentrated HNO3 and analyzed by ICP-MS. Results: The highest mean concentration of Al and Cr belonged to inlet waters of water treatment plant NO.2 in 1127 and 309ppb respectively. The lowest mean concentration of Al and Cr was seen in outlet waters of Byblos and Anahita in 0 and 65ppb respectively. The average concentration of Al in all inlet waters and outlet water of the water treatment plant NO.2 were above the limit set by the WHO. The average concentrations of Cr in the all water samples, except inlet to Anahita factory was significantly higher than the limit set by WHO. Conclusion: The results showed that the purification process causes reduction in content of metals in waters.

Keywords: Aluminum, Chromium, Treated water, Bottled water, ICP-MS.

Introduction

Today, nearly 1 billion people in the developing world do not have access to safe water. Water quality is an important issue for human health management.

Using of safe drinking water is one of the most importantfactors in water use that it has been noted from earlier years. Contamination with undesirable changes in the physical, chemical and biological, cause degradation water quality and in some stage are unusable (Derakhshan, Daneshvar et al. 2013).

The importance of water as one of the methods of disease transmission for public health officials around the world is so that WHO One of the indicators of health development in developing countries provides clean and sanitary water (Soradi-pur 2013).

Use of drinking water, one of the important ways that people are absorbed heavy metal[1]

Use bottled water for oral consumption is common in many societies, especially in areas where water quality is not suitable for this purpose (Anadu and Harding 2000)

According to the definition by the World Health Organization (WHO), drinking water is water which is fit for human consumption and suitable for all domestic applications[2]. It is obvious, human health depends on safe water and sanitation. Many health problems in developing countries emanates from unhealthy drinking water [3]. The Food and Agriculture Organization (FAO) which is affiliated with The United Nations, expressed that by 2025, 1.9 billion people live in countries or regions with absolute scarcity of water and two-thirds of the world's population will be under stress conditions[4].

Exposure to metals is mainly via intake of food and drinking water, drinking water being the most important source in most population. For this reason, the health authorities in each country have to confirm the safety of consumed water in communities and, the quality of drinking water must be checked continuously.

Since drinking water is one of the main sources to receive Al and Crelements, this study was conducted to compare Al and Cr levels in the water at the inlet to the bottled water factories and water treatment plant NO.2 in Ahvaz city and outlet water of them after the water treatment process.

2. Materials and Methods

Chemicals, Reagents and Materials

Mix standard solution containing Al and Crwere obtained from Perkin Elmer Co. (USA) at concentration 10 µg/ml, HNO_3, Whatman filter papers (0.45µm)

Cleaning glassware

All glassware was cleaned by soaking in 10% (v/v) acid nitric for 24 h, rinsing five times with Milli-Q water and dried in oven at 450ºC temperature.

Apparatus

Inductively Coupled Plasma–Mass Spectrophotometric devices (Perkin Elmer ELAN DRC 6000, USA). Typical daily instrumental used parameters are given in table 1.

Sampling

Sampling is one of the most important stages of the study. By using G power software, the number ofsamples required for each inlet and outlet WTP2,Byblus and Anahita factories was determined (84 water samples). Samples were taken fourteen times, each time; five, one–liter samples were collected. The samples were then mixed and one liter composite sample was isolated and transported to laboratory. The collected water samples were filtered by passing through filter papers (0.45µm). To protect and stabilize them, pH were adjusted ≤2 by concentrated HNO3 and were kept at 4 °C before the analysis[5].

Method of measuring

By preparing Al and Crstandards solutions in 1, 10, 25, 50, 75 and 100 ppb concentrations and measuring their concentrations with ICP-MS, calibration curves for Al and Crwere plotted. 27Al and 52Crisotopes were chosen. Al and Crlevels in collected water samples without any dilution or adding any materials were measured by ICP-MS method and their concentrations were calculated by calibration curves. Results were analyzed by Excel and SPSS 20 software.

3. Results

Results indicated that lines equations with correlations for Al and Crwere y=1.0542x+5.1415,with the coefficient of determination (R2) 0.9993 and y=10.3959x+92.1132, 0.9988 respectively.

The limit of detection (LOD) for Al and Crwere 0.3 and 0.03 ppb respectively and limit of quantification (LOQ) for both of them was 1ppb.

The concentrations of Al and Cr in investigated water and comparison their mean with limit set by WHO was shown in table 2 and 3.

Table 1. ICP-MS operating conditions

Spray chamber	Cyclonic
Nebulizer	meinhard
RF power (W)	1500
Argon flow rate	16l/min
Plasma	15 l/min
Auxiliary	0.8 l/min
Nebulizer	0.7-0.9 l/min
Detector	Dual-stage discrete dynode electron multiplayer
Mass filter	Quadropole
Dynamic range	8
Scan mode	peak hopping
Resolution (amu)	0.7
Replicate time(s)	1
Dwell time (s)	50
Sweeps/reading	20
Integration time (ms)	1000
Replicates	3
Isotopes	

Table 2. Descriptive statistic of aluminumconcentration in investigated water and comparison their mean with limit set by WHO (200 ppb)

Type water	Minimum (ppb)	Maximum (ppb)	Mean ± SEM (ppb)	Sig. (2-tailed) Test Value = 200 (ppb)
Inlet toWTP.2*	440	1600	1127±173	0.002
Outlet fromWTP.2	400	460	413±9	0.000
Inlet to Byblos factory	320	450	394±18	0.000
Outlet from Byblos factory	310	410	351±15	0.000
Inlet to Anahita factory	0	200	446±212	0.291
Inlet toWTP.2*	ND**	ND	ND	t cannot be computed

*Water Treatment Plant number 2 (WTP.2)
**Not Detectable (ND)

Table 3. Descriptive statistic of chromium concentration in investigated water and comparison their mean with limit set by WHO (50 ppb)

Type water	**Minimum(ppb)**	**Maximum(ppb)**	**Mean ± SEM(ppb)**	**Sig. (2-tailed) Test Value = 50 (ppb)**
Inlet toWTP.2*	138	631	309±70	0.010
Outlet fromWTP.2	52	435	131±52	0.171
Inlet to Byblos factory	1	148	77±19	0.209
Outlet from Byblos factory	25	107	65±9	0.170
Inlet to Anahita factory	40	129	79±13	0.073
Inlet toWTP.2*	29	305	101±40	0.246

*Water Treatment Plant number 2 (WTP.2)

4. Discussion

Results showed that the highest mean concentration of Al and Cr belonged to inlet waters of water treatment plant NO.2 in 1127 and 309ppb respectively.

The lowest mean concentration of Al and Cr was seen in outlet waters of Byblos and Anahita in 0 and 65ppb respectively. The comparison of the mean concentrations of Al and Cr in the Karun of inlet water treatment plant NO.2 with Karun water at outlet from water treatment NO.2 was seen a significant difference ($p<0.05$).

The comparison of the mean concentrations of Al and Cr in water at inlet to Byblus factory with water at outlet of Byblus factory was no significant difference (p>0.05).

The comparison of the mean concentrations of Al and Cr in water at inlet to Anahita factory with water at outlet of Anahita factory was no significant difference (p>0.05).

Ohno, K et al. studied the daily intakes of 17 metals (boron, aluminium, chromium, manganese, nickel, copper, zinc, arsenic, selenium, molybdenum, cadmium, antimony, lead, uranium, magnesium, calcium, and iron) via drinking water and total diet in six cities in Japan. According to their results of among the 13 toxic metals, mean dietary intakes of 10 (except arsenic, selenium, and molybdenum) were less than 50% of tolerable daily intake (TDI). For the 13 toxic metals, the contribution of drinking water to TDI was 2% or less in all six cities. Mean dietary intakes of the essential elements magnesium, calcium, and iron were less than the recommended dietary allowances (RDAs) or adequate intake (AI) values. The concluded that drinking water did not contribute much too essential metal intake, accounting for less than 10% of RDA or AI [6].

A research was conducted by R. Reza; G. Singh to reveal the seasonal variations in the river water quality with respect to heavy metals contamination. They collected water samples from twelve different locations along the course of the river and its tributaries on the summer and the winter seasons. They determined the concentrations of trace metals such as cadmium, chromium, copper, cobalt, iron, manganese, nickel, lead, mercury and zinc using atomic absorption spectrophotometer. Most of the samples were found within limit of Indian drinking water standard (IS: 10500). They used the data generated to calculate the heavy metal pollution index (HPI) of river water. Based upon their results, the mean values of HPI were 36.19 in summer and 32.37 for winter seasons and these values were well below the critical index limit of 100[7].

Memet Varol et al. measured the concentrations of total nitrogen (TN), total phosphorus (TP), As, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn in both surface water and sediment samples from the upper Tigris River to evaluate the level of contamination. Their data showed that all metal concentrations in water samples, except Cu, were lower than the maximum permitted concentration for the protection of aquatic life[8].

Kavcar, Pınar et al. done a research to assess the health risk for exposure to trace metals via drinking water ingestion pathway for Province of İzmir, Turkey and measured the concentrations of Be, Cd, Co, Cr, Cu, Mn, Ni, Pb, V, and Zn trace metals in drinking waters collected from 100 population weighted random sampling units (houses). The results showed that six trace metals (As, Cr, Cu, Mn, Ni, and Zn) were detected in >50% of the samples[9].

Results of this study showed that the average concentrations of Al in all water samples, except inlet water treatment plant NO.2 was significantly higher than the limit set by WHO(300ppb). The average concentrations of Cr in the all water samples, except inlet to Anahita factory was significantly higher than thelimit set by WHO (50ppb). The results showed that the purification process causes reduction in content of metals in waters, but reduction in plant No.2 was not statistically significant.

Because of the importance of metals in water, it is recommended:

Cyclical measurement of these metals by increasing the number of samples in drinking water and Bottled water manufacturing industries

Cooperation in the establishment of a reference laboratory on controlling food for monitoring contaminants.

Preparation and approval of the rules, regulations and guidelines for monitoring the performance of bottled water companies.

Compiling suitable Pattern for management and consumption of water resources.

Individually, at one meal, metals in foods are not troublesome but the problem is metals build up in our bodies from multiple sources and it creates health issues.

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