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Research Article

THE EFFECT OF WATER TREATMENT ON SELENIUM AND VANADIUM LEVELS OF WATER IN KARUN RIVER IN AHVAZ CITY, IRAN

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Abstract

Introduction: Due to the increase in world population and increased demand for safe drinking water, using of bottled water, especially in areas with a shortage of safe drinking water is common. The aim of this research was to compare Selenium and Vanadium levels in the water of Karun river at the influent stream of the water treatment plant number 2 (WTP2) and its outlet water after the water treatment process and waters of inlet and outlet of Byblus factory and Anahita factory in Ahvaz city. **Materials and Methods**: Fourteen samples of Karun river water at the inlet of Ahvaz WTP2 and its outlet water after the water treatment process and waters of inlet and outlet of Byblus factory and Anahita factory were collected during five months (September 2013, and January - April 2014). Samples were taken fourteen times, each time; five, one - liter samples were collected. The samples were mixed and one liter composite sample was isolated and transported to laboratory. The collected samples were filtered through filter paper (0.45 µm). For their fixation and protection, nitric acid was added and the pH was adjusted at**≤2.** All samples were analyzed by ICP-MS. **Results & Discussion:** According to the results, the highest and lowest mean concentration of Vanadium 14.22 and 6.17 ppb in Water inlet the water treatment plant NO (2) of Ahvaz and water at outlet from Anahita factory. The mean concentration of selenium because of the lower limit (0.1 ppb) was not measured with ICP-MS. **Conclusion:** The results showed that the purification process causes reduction in content of metals in water.

Keywords: Karun River, Selenium, Vanadium, Water Treatment Plant, ICP-MS.

Introduction

Using of safe drinking water is one of the most important factors 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 provide clean and sanitary water(Soradi-pur 2013).

Use of drinking water, one of the important ways that people are absorbed heavy metal(Kato and Buzalaf 2012).

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

Vanadium is one of the chemical substances in the water. The results of study suggest that Vanadium compounds similar to insulin effects in tissues. this substance act through at cytoplasmic protein tyrosine kinas that is separate from the insulin receptor tyrosine kinase(Sekar, Li et al. 1996).

The main use case is to catalyze the production of sulfuric acid. Vanadium in various industries, including the production of ceramics, polymers, synthetic rubber production had relatively large usage(Abed and Zabet 2013).

Industrial diseases caused by exposure to the element include Vanadium pentoxide(Bani-e'mam, Nejat-khah-manavi et al.).

Acute Contact with the metal created liver, kidney and digestive disease and in chronic contact, anemia, weight loss and diarrhea occur by different mechanisms(Domingo, Llobet et al. 1985).

Another heavy metals in the water, selenium, is necessary for selenoprotein that protected cells from damage by oxidative agents(Allan, Lacourciere et al. 1999).

Selenium and sulfur exist in many ores and coal. Usually concentrations in drinking water is less than one mg/L, but in some areas is more than 2.5 mg/L (Weiss, Hogan et al. 1997).

Selenium deficiency in humans occurs as Keshan disease that is an endemic cardiomyopathy (Chen, Yang et al. 1980).

Selenium extraction and burning of fuels containing that, affects the respiratory tract and causes severe inflammation, bronchospasm and pneumonitis (Rotruck, Pope et al. 1973).

In this study, because of importance of water as well as failure to do enough research on the chemical quality of the water, we measure the amount of Selenium and Vanadium in these waters Allows comparison of the two entrance water to bottled water production plants and water Ahvaz Karun at the inlet to the water treatment plant No.2 with output of them after treatment process, is provided and daily intake of Selenium and Vanadium in drinking water is calculated Ahwaz citizens.

Materials and Methods

Materials and methods

Mixed standard solutions containing Selenium and Vanadium were obtained from Perkin Elmer Co. (USA) at concentration 10 µg/ml**;** HNO3, Whatman filter papers (0.45µm).

Cleaning glassware

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

Apparatus

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

Table.1. ICP-MS operating conditions

Spray Chamber	**Cyclonic**
Nebulizer	**Meinhard**
RF power (W) Argon flow rate	**1500**
Plasma	**15 l/min**
Auxiliary	**0.8 l/min**
Nebulizer	**0.7-0.9 l/min**
Detector multiplayer	**Dual-stage discrete dynode electron**
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	**^{48}Ca' ^{9}Be**

Sampling

Sampling is one of the most important stages of the study. By using G power software, the number of samples required for each inlet and outlet WTP2, Byblus factory and Anahita factory 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 was adjusted at ≤2 by concentrated HNO_3 and was kept at 4 °C before analysis (Gasche et al., 2007).

By preparing selenium and vanadium standards solutions at 1, 10, 25, 50, 75 and 100 ppb concentrations and measuring their concentrations with ICP-MS, calibration curves for Selenium and Vanadium were plotted. ^{72}Se and ^{51}Visotopes were chosen. Selenium and Vanadium levels 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.

Results

Equations with correlations for Selenium and Vanadium were y=3.371x+25.94, with the coefficient of determination (R^2) 0.999 and y=1.056x+5.606, with the coefficient of determination (R^2) 0.996 respectively.

The average recoveries and relative standard deviation (RSD %) for intraday and inter days of the applied analytical methods for Selenium and Vanadium in water are in shown (Table. 2).

All recoveries were more than 95%, indicating the high accuracy of the method. The limit of quantification (LOQ) for Selenium and Vanadium were 0.1 and 0.1 ppb.

The concentration range of Vanadium in Karun River water at the inlet stream of WTP 2, waters at inlet to Byblus and Anahita factories was 9-29, 6-21 and 8-30, ppb respectively (Table 3).

The concentration range of Vanadium in Karun River water from the outlet stream of WTP 2, waters from outlet to Byblus and Anahita factories were 8-23, 4-22 and 4-8 ppb, respectively. The mean concentration of Selenium was under LOQ.

Table.2. Recoveries and RSD% for Intraday and Inter day for Selenium and Vanadium from spiking into the one of the water samples (n=6)

Element	Conc (ppb)	Intraday		Inter day	
		Recovery (%)	RSD(%)	Recovery (%)	RSD(%)
Se	1	97	18.58	97	5.9
	10	97	22.25	96	6.5
	25	97.5	19.63	98	7.45
	50	98	13.40	97.5	6.2
	75	98.2	19.40	98	6.9
	100	98	17.68	96	6.1
V	1	97.3	7.97	96	11.2
	10	98.5	26.26	97.9	16.9
	25	99.1	12.49	96.5	7.8
	50	98.8	7.02	98	8.75
	75	97.4	9.01	97	9.35
	100	98	6.06	98	7.7

Table.3. Descriptive statistic of Vanadium concentration in investigated water and comparison their mean with limit set by WHO.

Type of water	Minimum (ppb)	Maximum (ppb)	Mean ± SEM (ppb)	Sig. (2-tailed) Test Value = 100 (ppb)
Karun at inlet to water treatment plant No.	9.00	29.00	22.14±2.53	0.01
Karun water at outlet from water treatment NO.2	8.00	23.00	12.57±1.88	0.001
water at inlet to Byblus factory	6.00	21.00	15.14±1.86	0.01
water at outlet from Byblus factory	4.00	22.00	10.28±2.97	0.014
water at inlet of Anahita factory	8.00	30.00	19.71±2.98	0.001
water at outlet from Anahita factory	4.00	8.00	6.71±0.60	0.01

Discussion

Statistically, the highest mean concentration of Vanadium belonged to Karoun at inlet of Water Treatment Plant NO.2 (22.14 ppb).

The comparison of the mean concentration of Vanadium in the Karun of inlet water treatment plant NO.2 with Karun water at outlet from water treatment NO.2 and water at inlet to Byblus factory and water at inlet of Anahita factory there was no significant difference($p>0.05$).

The comparison of the mean concentration of Vanadium in the Karun of outlet water treatment plant NO.2 with water at outlet of Byblus factory and water at outlet of Anahita factory there was no significant difference($p>0.05$).

The comparison of the mean concentration of Vanadium in water at inlet to Byblus factory with water at outlet of Byblus factory and water at inlet of Anahita factory there was no significant difference($p>0.05$).

The comparison of the mean concentration of Vanadium in water at outlet to Byblus factory with water at outlet of Anahita factory there was no significant difference ($p>0.05$).

The comparison of the mean concentration of Vanadium in water at inlet of Anahita factory with water at outlet of Anahita factory was seen a significant difference ($p=0.004$).

Linbo Xia, et al. in 2006 by ICP-MS measured amount of selenium in natural waters for Se^{4+} 0.5-0.56and$forSe^{6+}$, 2.7-3 pg/ml and like our study in compared with then at national standard limit, International standards and WHO which are three ppb 100 is lower(Xia, Hu et al. 2006).

Y. Martinez-Bravo, et al. in 2001, measured the amount of selenium in drinking water using a combination of ICP-MS-HPLC. The result for Se^{4+}, 1.2, and for Se^{6+}, 1.4 µg/L and in compared with the national standard limit , international and WHO is lower(Martınez-Bravo, Roig-Navarro et al. 2001).

In the study by Anna Trebunskaya, et al. in 2010 to measure Selenium in water and drinking water by ICP-OES device were Selenium measured mineral water 0.7-2.1 and in drinking water0.25mg/L That as we study are less than national standard limit, global and WHO(Tyburska, Jankowski et al. 2010).

K. Gavosov, et al. 2000, measured the amount of Vanadium in natural water by ICP-MS,15µg/L, which was lower than the national standards limit, international and WHO(Gavazov, Simeonova et al. 2000).

China-ching wann, et al. in 1997, measured the amount of Vanadium in water by ICP-MS of the around for V4 +, 0.025 and V5 +, 0.041 ng/L was recorded lower than national standards limit, international and WHO(Wann and Jiang 1997).

In a study by Huitao Liu, et al. in 2002 with ICP-MS analysis was performed the Vanadium in water samples forV4 +, 0.007 and V5 +, 0.013 ng/L was measured that Lower than national standard limit, international and WHO(Liu and Jiang 2002).

Kuei-Ling-Yans, et al. in 1996, measured amount of Vanadium in various water samples by ICP-MS, 0.001 ng/L lower than national standard limit, international and WHO(Yang, Jiang et al. 1996).

The results showed that the mean concentration of Vanadium in the entrance water to the plant number two in Ahvaz and the water outlet and inlet and outlet Anahita Byblos bottled water plants and that are available to the public, According to the1053 guidelines and WHO and national standard limit, the amount of Selenium and Vanadium 100 ppb are considered, were lower than the international standard, and given the importance of these metals in the human body can be concluded that Lack of long-term causes of problems and diseases related to the lack of these metals in humans. That is why in many countries, consumer foods such as cereals are enriched with Selenium with genetic alterations, and in many provinces such as Khuzestan, Food and Drug Administration has decided that flour used in bread enriched with Selenium.

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