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Check of arsenic in drinking water sources in the cities of South Khorasan in the year 2011

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ABSTRACT

Arsenic may be natural or synthetic in water. Arsenic is a toxic element that will be created many complications in human body. Our goal is to check arsenic levels in drinking water sources in the cities of South Khorasan in this study. Sampling was done in 1 liter polyethylene containers according to standard conditions by the experts were trained in environmental health. Samples were transferred to the laboratory and related tests were performed in accordance to recommended standards and atomic absorption system with graphite furnace method. Results were consistent with national and international standards and were judged about the status of water resources. The arsenic average was determined 0.01 ± 0.0059 with a minimum of zero and a maximum of 0.053 in 84 samples in this study. Arsenic levels are more than allowable maximum in Sarbisheh and Sarayan cities. The lowest arsenic in drinking water sources was observed in Nehbandan City (zero) and the highest arsenic in Sarbisheh City ($x=0.036$). The average of arsenic levels was significantly lower than the standard in the cities of Birjand, Ferdows, Ghaen and Boshruyh. Except of Sarbisheh and Sarayan that arsenic levels are more than allowable maximum, arsenic levels has not gone beyond the allowable maximum in other cities.

Key Words: arsenic, drinking water, South Khorasan

INTRODUCTION

Arsenic is an element that exists everywhere and the natural environment. Arsenic in groundwater has a natural source but arsenic in surface waters occurs mostly due to human activities. Arsenic in the remaining sludge from water creates many problems in the sludge disposal. Arsenic has toxicity and has Mutagenic, teratogenic and carcinogenic effects in the human body [1]. Arsenic has been classified in Group A as Carcinogenic in humans on sufficient evidence by the U.S. EPA and IARC [2 and 3]. Arsenic is a poisonous metalloid that has been known since ancient times. Today, arsenic compounds uses as a toxic compound in pesticides, insecticides, herbicides and chemical warfare [1]. Arsenicosis is one of the most serious environmental diseases that caused by this chemical material and has affected large populations around the world and appears symptoms such as skin ailments (skin ulcers, Melanosis and Hyperkratusis). Skin ulcers, peripheral vascular disease, blood pressure, black foot disease and high risk cancers have been reported in people that were faced with high concentrations of arsenic in drinking water [4]. Millions of people are exposed to arsenic mainly through drinking water that are contaminated naturally.

Some believe that this is the largest annual environmental disaster and is more serious from the Bhopal case in 1984 and Chernobyl in 1986. International Agency of Cancer Research has been classified arsenic in drinking water in one carcinogen group. [5]. Arsenic usually sees as Arsenate or Arsenite in water resources. Arsenate (H_3AsO_4 , H_2AsO_4^- , HASO_4^{2-} , OR ASO_4^{3-}) mainly to form one and bivalent anions in waters with high oxygen and Arsenite (H_3AsO_3 , H_2AsO_3^- , HASO_3^{2-}) are found in oxygen-deficient waters [6]. Heavy metals can accumulate in living body and cause various diseases and disabilities. These metals in various industrial processes such as melting, purification or extraction of released into the environment through the publication of polluting gases or industrial wastewater. These metals are not biodegradable [7] Toxic metals are harmful to humans and other organisms in the small amount Toxic metals that are soluble in water, including arsenic, barium, cadmium, chromium, lead, mercury and silver. Metals that can accumulate in the human body such as arsenic, cadmium, lead and mercury, are particularly dangerous. These metals condensate through the food chain, and are important risk for organisms that are in the chain top [8]. Arsenic is a toxic element in water [9]. According to a report published in 2010, arsenic in water is endangered Health more than 100 million people that Exposed to more than the maximum allowable concentrations have been recommended by the World Health Organization in different parts of the world. [10]. Arsenic in drinking water increases the mortality through various cancers, heart disease, pulmonary tuberculosis and other diseases [11]. Neurological problems, blood pressure, respiratory problems, skin cancer should also be added to the problems caused by the arsenic. Chronic problems that cause by arsenic should be considered [12]. The arsenic levels are estimated between 9.7 to 12.2 mg/kg body weight in the diet daily [13]. High concentration of arsenic in drinking water is associated to increase cardiovascular diseases. In Taiwan, People that have long been exposed to arsenic are infected the black foot disease (black foot disease) [14]. According to national standards of Iran [15] the maximum permissible levels of arsenic in drinking water is 10 micrograms per liter. the World Health Organization [16] the maximum permissible levels of arsenic in drinking water is 10 micrograms per liter, which is the basis for assessment cancer risk is caused by arsenic. In some countries such as Australia, the standard has dropped to 7 micrograms per liter. On the other hand, more serious problem is in India and Bangladesh that this standard is 50 micrograms per liter now [17]. The maximum acceptable concentration of arsenic in drinking water is 25 micrograms per liter in Canada [18]. Several studies have been done in Iran and other countries about the arsenic levels in water. In Iran, in Kohsorkh region of Kashmar [19] in Bijar villages [20] and Ghopuz in East Azarbayjan [4] and Hashtroud in East Azarbayjan [21] studies is done on arsenic levels in drinking water that arsenic levels have been more from national and international standards. Studies have been done about arsenic concentration in other countries [10, 12, 13 and 22] that arsenic levels was higher than recommended standards in the most of them. Ground water pollution to arsenic is particular interest as a major problem in many countries and millions of people are exposed to arsenic-contaminated drinking water that exists naturally in groundwater in world [23]. Now, arsenic remove is a challenge from drinking water and irrigation water, especially in developed countries [24]. At the first, we should know that is there this toxic element or not? in drinking water in South Khorasan province, So ground layers have a major role to arsenic concentration and drinking water in this region of Iran is supplied by groundwater, our goal was to determine arsenic in drinking water sources in different cities in southern Khorasan at the present study.

MATERIALS AND METHODS

This study was conducted in 2011 and our goal was to determine arsenic levels in drinking water sources in this province. Therefore, the exact geographical position and supplier sources of drinking water that are ground water were found. Samples were collected at the specified intervals. Sampling was conducted as a census and in One-liter polyethylene dishes in standard conditions and according to 2348 standard of Standards Institute and Industrial Research of Iran [15] it was done by health experts. Water samples were transported to the laboratory under standard conditions. Relevant tests were performed with atomic absorption system to graphite furnaces method according to standards recommended in the standard method book. (Method No. 3111) [25]. The atomic absorption was Atomic Absorption Spectrophotometry shimadzu AA6300). Results were matched with 1053 standard of Standard Institute and Industrial Research of Iran [15] and standards of the World Health Organization(who) [16] and were judgment about the status of water resources in cities. The maximum permissible levels of arsenic in drinking water is 0.01 mg per liter according to 1053 Standard of Standards Institute and Industrial Research of Iran and the World Health Organization standards, (permissible levels is from physical, chemical, biological and radioactive properties of drinking water that its consumption has not adverse effects to human health in the short term or long term).

RESULTS AND DISCUSSION

This study was conducted on 84 supplier sources of drinking water. From 84 samples, 30 samples was in Birjand, 6 samples in Nehbandan, 8 samples in Ferdows, 8 samples in Sarayan, 7 samples in Darmian, 3 samples in Boshruyh, 19 samples in Ghaen and 3 samples in Sarbishe cities. Arsenic average was determined 0.01 ± 0.0059 in 84 samples with a minimum of zero and a maximum of 0.053 mg per liter. Arsenic average in drinking water shows on a table [1] by city.

Table (1) Comparison of arsenic in drinking water sources by City

Statistical indicators City	Abundance	average	Standard deviation	ANOVA and Tukey test
Birjand	30	0.0054	0.008	*f=7.67 df=7.76 p<0.001 The Tukey test: * Birjand with Sarayan : p= 0.03 * Birjand with Sarbishe : p<0.001 * Nehbandan with Sarayan : p=0.02 * Nehbandan with Sarbishe: p<0.001 * Sarayan with Ferdows : p=0.01 * Ferdows with Sarbishe : p<0.001 Darmian with Sarbishe, Boshruyh with Sarbishe, Ghaen with Sarayan, Ghaen with Sarbishe was significant with p<0.001
Nehbandan	6	0	0	
Ferdows	8	0.0007	0.002	
Sarayan	8	0.017	0.019	
Darmian	7	0.0052	0.007	
Boshruyh	3	0.0008	0.001	
Ghaen	19	0.002	0.005	
Sarbishe	3	0.036	0.021	
Total	84	0.0059	0.01	

* $\alpha = 0.05$ is Significant

Significant difference was observed in arsenic average in drinking water sources in various cities according to data from Table 1. The lowest arsenic levels was observed in Nehbandan (zero) and the highest arsenic levels in Sarbishe ($X = 0.036$). According to the drinking water standard of Iran (1053 Standard of Standards Institute and Industrial Research of Iran), the maximum permissible levels of arsenic in drinking water is 0.01 mg per liter. The standards recommended by the World Health Organization standards are the same. So, arsenic level was more than the maximum permissible levels in Sarbishe and Sarayan. The average of the arsenic levels has been compared with together in drinking water sources in different cities in Table 2.

Table 2: Comparison of arsenic in drinking water sources with national and international standards (the maximum permissible levels =10 µg/l, WHO)

Town	X±SD	one sample	T-test
Birjand	0.008±0.0054	*t= 3.1 df=29	p= 0.004
Nehbandan	0		0
Ferdows	0.002±0.0007	*T=13.1 df=7	p<0.001
Sarayan	0.019±0.017	T=1.1 df=7	p= 0.33
Darmian	0.007±0.0052	t=1.7 df=6	p=0.14
Boshruyh	0.001±0.0008	*T=13.8 df=2	p=0.005
Ghaen	0.005±0.002	*T=6.4 df=18	p<0.001
Sarbishe	0.021±0.036	T=2.1 df=2	p=0.17
Total	0.01±0.0059	T=3.3 df=83	p=0.001

* $\alpha = 0.05$ is Significant

According to above table 2, the average of the arsenic levels was significantly lower than the standard in Birjand, Ferdows, Ghaen and Boshruyh, but significant difference was not observed in Sarayan, Darmian, Sarbishe with standard. The average of the arsenic levels was higher than maximum standard in Sarbishe and Sarayan. In this study, an arsenic level was measured in 84 samples that were produced from drinking water sources in various cities of South Khorasan. The average of the arsenic levels was 0.01 ± 0.0059 with minimum of zero and maximum of 0.053 mg per liter. Table 1 shows that the average of the arsenic levels is more than maximum permissible levels according to standards of Iran [15] And the World Health Organization standards in Sarayan and Sarbishe [16] (maximum permissible levels was recommended 10 micrograms per liter or 0.01 mg per liter by these organizations). In other cities, the average of the arsenic levels is not more than maximum permissible levels. Arsenic level was zero in Nehbandan. The average of the arsenic levels was significant according to statistical tests between many cities in South Khorasan that value P is reflected in the table [1]. Table 2, the average of the arsenic levels is seen in drinking water sources in cities of South Khorasan that Sarbisheh is more than the maximum permissible levels according to national and international standards. But in other cities are significantly less than the maximum permissible levels. In a study that was done in Khorasan Razavi in Kohsorkh region of Kashmar on a

river, the highest arsenic levels was 52.93 micro grams per liter in winter. In the fall was 15.65, Summer 7.84 and Spring 13.62 micrograms per liter. High arsenic level was known because of weathering and resulting changes in minerals in this region. The most important minerals are Arpmnt and Ralgar in the region that is contaminated surface and underground waters. Arsenic concentration is very high in this area as compared with non-contaminated soil and varies from 210 to 260000 ppm. [19]. In another study that was conducted in Yazd province and Tabas area, Tabas coal attributes were checking about geochemical and the impact of the mining on soil contamination were determined with sampling from stream sediments. Arsenic concentration was very high in these samples that can also be related to high arsenic in coal. All analyzed elements in samples were higher than international standards that can be a serious threat to the environment and groundwater in region [26]. So, in these studies were pointed to soil pollution and ground layers, which have led to groundwater pollution to arsenic. So, it's necessary that studies are done about ground tissue and various layers that cross underground water resources it in Sarayan and Sarbishe. There are several reports about arsenic poisoning from contamination drinking water in various countries. In Asia, currently six areas have been identified with high concentrations of arsenic in groundwater, including Cambodia, the Democratic Republic of Laos, Pakistan, Myanmar, Vietnam, Nepal. Kurdistan and West areas of Iran have this problem too [23]. Mr Mesdaghinia and his partners did a study on drinking water in 44 villages in Bijar and resulted that there is arsenic contamination in the waters of this region [20]. In another study that was conducted on the waters of Hashtrud in East Azarbaijan and got to this result that there is arsenic contamination in rural water and The origin of this contamination has been Zhozhnyk [21] In another study that was conducted in the village of Qupuz in East Azarbaijan, has been reported very high arsenic contamination also [4]. These reports show that there is contamination in the areas in Iran. So, complete studies should do about ground tissue and minerals that there are in different areas in South Khorasan Province. The author had an investigative article about arsenic levels in Esfahan. Arsenic levels had been less than the recommended standards [27] in Esfahan. South Khorasan is a non-industrial area, so pollution origin to arsenic can't be air pollution. Therefore, except ground tissue, we should do studies on Pollutants that may lead to water pollution by artificiality such as insecticides in agriculture and wood industry [28] because there are agricultural activities in the contaminated areas. Several studies have been done, the most of them have been reported groundwater pollution to arsenic [10, 12, 13, 22, 28, 29, 30 and 31]. Villages where arsenic levels was above the maximum permissible levels, there were arsenopyrite minerals (arsenopyrite), gold, lead, zinc and purification, melting factories these materials and water had been contaminated by residuals or wastewater these industries in some cases [11]. In other study that was done about natural arsenic contamination in an area of 50,000 km² in Argentina, Arsenic, vanadium, chromium, iron and barium were reported more than the maximum permissible levels in drinking water [12]. Another study was concluded in Pakistan to determine arsenic in groundwater, lake water, soil, etc. that arsenic concentration in sediments of lakes and groundwater were more than standards were recommended by the World Health Organization [13]. A study was done in East Bengal in India on the ice and ground water, Arsenic levels was more than maximum permissible levels were recommended by the World Health Organization at %96. Arsenic had found through the layers of earth into groundwater [22]. A study in Spain was done to arsenic levels in public water supply network that the average of the arsenic was Variable less than 1 to 118 micrograms per liter and was also associated with increasing mortality by cardiovascular diseases [14]. We should also be noticed to the role that other foodstuffs have in the accumulation of arsenic in the body. A study was done on Absorption arsenic amount by wheat and maize in Pakistan, in two samples was performed, one sample were irrigated with well water, and other with surface waters, very high and significant arsenic accumulation was observed in wheat and corn samples were irrigated by well water. Arsenic levels is much more than usual in agricultural soils of Argentina, Chile, Bangladesh and Taiwan that are irrigated with groundwater, and arsenic can get into the food chain in this way. Thus the water of the wells is not suitable for drinking, cooking, and agriculture in arsenic-contaminated areas [30]. Arsenic accumulates in rice that was irrigated with this water [32]. Sarbishe and Sarayan cities have agricultural activities and are produced various agricultural products in them. So must be done studies on agricultural products in these areas in this study. Arsenic levels was measured in these studies is identical with the values obtained in this study. The methods are commonly used to remove arsenic from water including ion exchange, reverse osmosis, chemical precipitation and are methods of using the membranes that are often cost and cannot use for the large amounts of the water and has been proved that some plants can absorb arsenic in water, so biological Absorption methods could be the perfect solution for these regions [19].

CONCLUSION

Arsenic level in drinking water is greater than the maximum permissible levels in Sarbishe and Sarayan cities. In these regions, there are not industries that can artificially cause water pollution to arsenic, so contamination source

can be geological that should also be studied in this context and remedy about arsenic removal from water these areas. Arsenic level is not more than the maximum permissible levels in drinking water in other cities.

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