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Mercury and Lead Contamination Study of Drinking Water in Ahvaz ,Iran

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ABSTRACT: Heavy metal contamination of water could occur anywhere at resources, course of distribution or consumption place. Precise knowledge on amount and type of water pollutants especially heavy metal are essential to protect the environment, and public health. Heavy metal owning long biological half-life and their excessive amount in the body are a life treating hazard. Some trace elements of heavy metals constitute in nature. Entry of heavy metals into water supplies from various ways, cause side effect such as poisoning hazards, cancer. This survey aimed to evaluate concentration of heavy metal (Lead, Cadmium, and Hg) in drinking tap water of Ahvaz city by atomic absorption spectroscopy methods. A descriptive – analytical and cross-sectional study was conducted for determination of Lead, Cadmium and Mercury as heavy metals in 100 samples of six geographical regions from 48 sites in three consequent months in spring 2013. Samples prepared with concentrated nitric acids then Concentration of Pb and Cd determined by electro thermal methods and Hg concentration evaluated using cold vapor technique. Result shows that concentrations of Cd in drinking water (about 0.0012 mg/L) are below standard limits of World Health Organization (WHO). Unlike Cd, concentration of Pb crossed WHO standard limits among all samples. Mean concentration of Pb was 0.02 mg/L where highest amount recorded in western regions. Approximately 33% of samples show high concentration of Hg in camper to national standards of 0.006 mg/L. Mean concentration of Hg was 0.0047 mg/L. Lowest and highest value reported in eastern and north east of Ahvaz, respectively. We found similar concentration of Pb through all regains. However, mean concentration of Hg and Cd varied from site to site. Our study showed concentration of selected heavy metal (Pb and Hg) in drinking water of Ahvaz is higher than standards levels. We recommend further studies to determine the sources and cause of the pollution.

***Keywords*:** Mercury, Lead,atomic absorption, drinking water, Ahvaz

INTRODUCTION

Heavy metals are one of the most important factors for determining water quality due to potability. WHO estimates that about a quarter of the disease facing mankind today occur due to prolonged exposure to environmental pollution(WHO and International Programme on Chemical Safety, 2002; Azimi and Sadeghi Moghaddam, 2013) . Nowadays, pollution is mainly caused by local oil refineries and industrial plants .Cadmium , Lead and Mercury are the most chemical contaminants that threaten the water quality as drinking water or potable water defined water safe enough to be consumed by humans .Contamination of drinking-water may occur

as a result of the presence of cadmium as an impurity in the zinc of galvanized pipes or cadmium-containing solders in fittings, water heaters, water coolers and taps (WHO, 2005). Cadmium concentrations in unpolluted natural waters are usually below 1 µg/l (Friberg et al., 1986). Median concentrations of dissolved cadmium measured at 110 stations around the world were <1 µg/l, the maximum value recorded being 100 µg/l in the Rio Rimao in Peru (WHO/UNEP, 1989). Following the industrial revolution, using Mercury in industrial processes significantly increased remarkably. Mercury is / has been used for the cathode in the electrolytic production of chlorine and caustic soda, in electrical appliances (lamps, arc rectifiers, Mercury cells), in industrial and control instruments (switches, thermometers, barometers), in laboratory apparatus and as a raw material for various Mercury compounds (WHO, 2005). Nowadays Mercury is used as electrodes and reagents, antiseptics, fungicides, preservatives, pharmaceuticals. In many countries Mercury's industrial uses have been decreasing because of environmental concerns and environmental legislation . Many studies have so far been published on heavy metal contamination because of their effects on human health and ecosystem (Caussy et al., 2003; Liu et al., 2005; Buschmann et al., 2008; Mousavi et al., 2013). Heavy metals such as lead, Mercury, cadmium, chromium, arsenic and aluminum have harmful effects on human health (Mousavi et al., 2013). Mercury is one of the most toxic elements and a threat to wild life because it accumulates and magnifies to unsafe levels in aquatic food chains (Madison , 2007). All Mercury species is toxic, with organic Mercury compounds generally being more toxic than inorganic species (Leopolda, 2010). The ingestion of acute toxic doses of any form of Mercury will result in the terminal signs and symptoms, namely shock, cardiovascular collapse, acute renal failure and severe gastrointestinal damage. Acute oral Mercury poisoning results primarily in haemorrhagic gastritis and colitis; the ultimate damage is to the kidney (WHO ,2005). Clinical symptoms of acute intoxication include pharyngitis, dysphagia, abdominal pain, nausea and vomiting, bloody diarrhoea and shock. Later, swelling of the salivary glands, stomatitis, loosening of the teeth, nephritis, anuria and hepatitis occur (Stockinger, 1981).

The present study was initiated to investigate the levels of contamination with heavy metals : Lead, Cadmium and Mercury and then determine and emphasis on the toxicological implications of heavy metal concentration in drinking water.

MATERIALS AND METHODS

Sampling method

A descriptive – analytical and cross-sectional study was conducted for determination of Lead , Cadmium and Mercury as heavy metals in 100 samples of tap water of Ahvaz city (capital of Khuzestan province, in the south of Iran) in spring 2013 by atomic absorption spectroscopy methods.

Study Area

Ahvaz is the capital of the Iranian province of Khouzestan. It is built on the banks of the Karun River and is situated in the middle of Khouzestan Province (31°19'45" N and 48°41'28" E). The city has an average elevation of 20 m above sea level. Ahvaz is an industrialized city and the major parts of oil industries are located there. Also, some other industries such as steel and pipe processing companies, and carbon black manufacturing are adjacent the city (Sekhavatjou et al., 2011). Due to this, 100 samples of six geographical regions from 48 stations in three consequent months in spring 2013 were monitored. The name and description of all the stations are provided in figure 1.

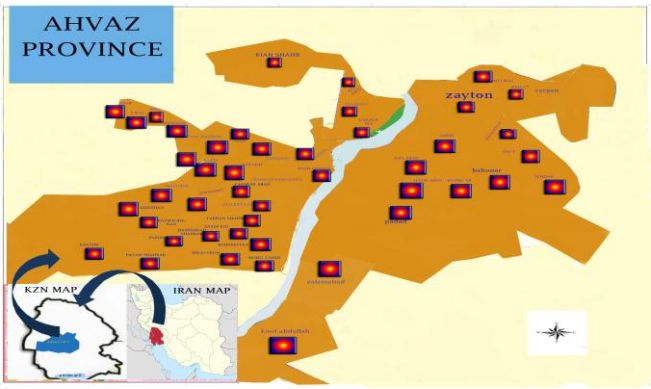

Figure 1. Description of water sampling stations in Ahvaz city, Southwest of Iran

Lead and Cadmium Determination

100 samples were collected and stored in clean acid-washed polyethylene bottles, following the sampling routines set for water quality studies (APHA, 1985). After collection and delivery to the Food and Drug Safety Evaluation Research Center of Jundishapur University of Medical Sciences, the water samples were acidified with HNO_3 to a pH <2. Prior to the chemical analysis, water samples were filtered through a Whatman glass microfibre filter (GF/C). The concentration of Cadmium and Lead were measured in the samples by Graphite furnace Atomic Absorption Spectrometry technique. The samples were analyzed by Varian AA240FS (Australia) for heavy metals: Pb and Cd, using at least five standard solutions for each metal and determination of Mercury content was followed by cold vapour atomic absorption spectrometry method(APHA, 2005).

Statistical Method

The differences on the basis of the geographical region of tap water were determined by student t-test. Heavy metal concentration changes were calculated by one way Anova and for analysis of the role of multiple factors univariate analysis was used by SPSS 17.Probability values of <0.05 were considered significant.

RESULTS AND DISCUSSION

The results were determined as mean ± SD of three replicates in each test. The results in figure 3 and figure 4 revealed that the most samples in Ahvaz city had Mercury and Lead contents above Maximum Contaminant Level (MCL) **:** 0.002 milligrams per Liter (mg/L) or 2 parts per billion (ppb) Mercury and 0.01 mg/L Lead content which is recommended by EPA and WHO (US/EPA, 2013; WHO, 2007) although maximum level of Mercury and Lead were present in detectable amounts in the most studied samples while cadmium content (figure 2) in all samples was lower than permissible levels of WHO 0.003 mg/L (WHO, 2007; US/EPA, 2013; ISIRI,1998) . To understand the relationships between different geographical situation of sites and level of contaminants, ANOVA and t-tests analysis were used. The amounts of Mercury and Lead in the tap water of Ahvaz were significant in the different locations ($p<0.01$) and ($p<0.03$) respectively. Approximately 33% of samples show high concentration of Hg in camper to national standards of 0.006 mg/Lit (ISIRI,1998).Table -1 shows the mean level of heavy metal contents (mg L^{-1}) ±SD of Ahvaz drinking water samples studied in different geographical regions in spring 2013. The results show that Mercury concentrations in both center and northeast have significant differences ($P < 0.03$) as well as Mercury contents in residential and industrial areas ($P < 0.01$).

Table 1. The mean level of heavy metal contents (mg L^{-1}) ±SD, in geographical regions in spring 2013

Geographical Regions	Cd (mg L^{-1}) ±SD*	Pb (mg L^{-1}) ±SD*	Hg (mg L^{-1}) ±SD*
Station1(Eastern North)	0.0013±0.0000	0.024±0.0069	0.0061±0.0002
Station2((Eastern)	0.0011±0.0000	0.021±0.0050	0.0060±0.0002
Station3(North)	0.0011±0.0000	0.021±0.0078	0.0051±0.0001
Station4(Center)	0.0011±0.0000	0.019±0.0064	0.0050±0.0002
Station5(Western)	0.0011±0.0000	0.019±0.0058	0.0034±0.0004
Station6(Western South)	0.0011±0. 0001	0.016±0.0044	0.0028±0.0003

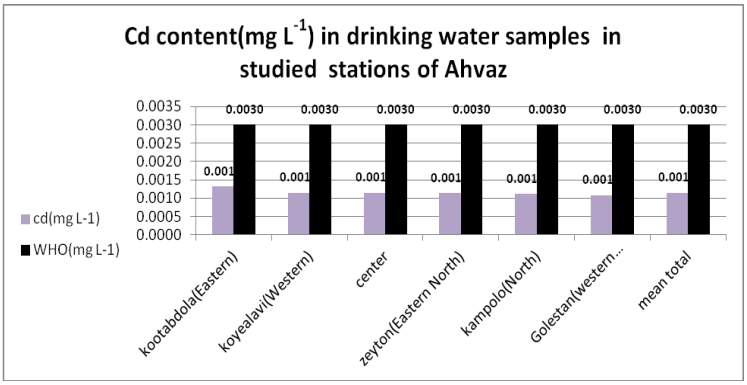

Figure 2. The Mean content of Cadmium (mg/Lit) in drinking water samples in studied stations of Ahvaz 2013

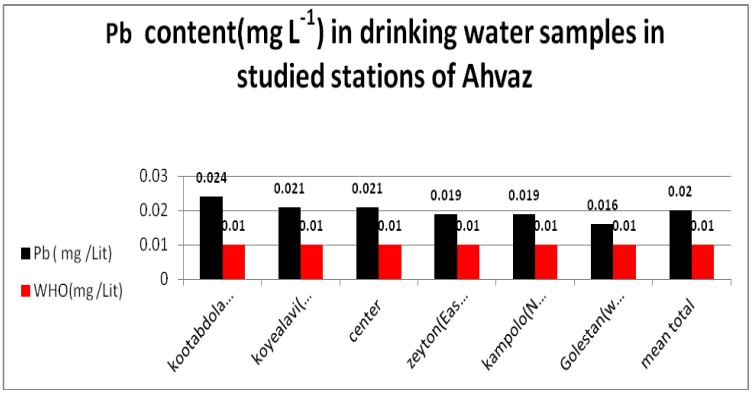

Figure 3. The Mean content of Lead (mg/Lit) in drinking water samples in studied stations of Ahvaz

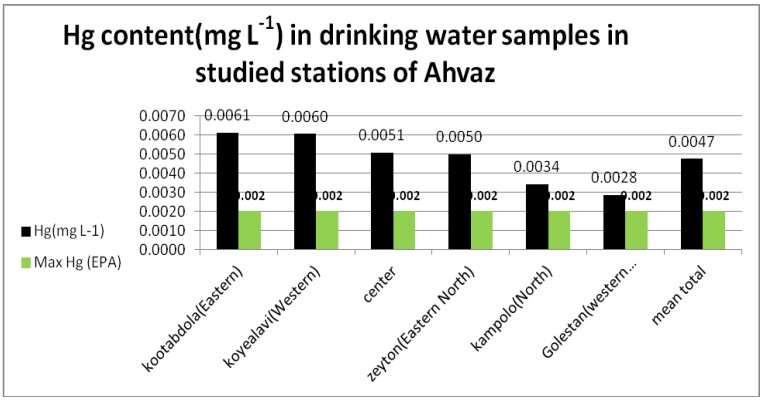

Figure 4. The Mean content of Mercury (mg/Lit) in drinking water samples in studied stations of Ahvaz

It is clear that the result of our study shows a variation in the Lead and Mercury levels in the different stations of the city(table 2).

Table 2. Range of Lead, Cadmium and Mercury contents in drinking water samples from 48 stations of Ahvaz in spring 2013.

Min Hg content (mg L^{-1}) ±SD*	Max Hg content (mg L^{-1}) ±SD*	Min Cd content (mg L^{-1}) ±SD*	Max Cd content (mg L^{-1}) ±SD*	Min Pb content (mg L^{-1}) ±SD*	Max Pb content (mg L^{-1}) ±SD*
0.0028±0.0001(mg/L^{-1})	0.0061± 0.0004 (mg/L^{-1})	0.0011±0.0001(mg/L^{-1})	0.0013± 0.0000(mg/L^{-1})	0.016±0.0044(mg/L^{-1})	0.024±0.00069 (mg/L^{-1})

*SD= Standard Deviation

Most of the examined drinking water collected in Ahvaz , capital of Khuzestan in present study is polluted and Lead and Mercury concentrations are higher than WHO guidelines, EPA standards and ISIRI (Iranian drinking water Standards :NO 6694 and 1053) and probably have public health problem by their consumption and constantly determination of heavy metals should be measured by responsible organizations. The results show that the Mercury pollution in Ahvaz city is more than other places in Iran. In this study, the Mercury content in different stations in city were compared with each other by statistical calculations and the results showed there's a significance different between Mercury contents in different geographical location of city. Significant variation in the concentrations of Mercury and Lead in Tap water in Ahvaz is probably the result of industrial operations and concluding accumulation of pollutants. The heavy metal pollutions probably is the result of many manufacturers and refinery in the region contain Mercury.

Some health authorities have suggested that people drink at least eight glasses, eight fl oz each (240 mL), of water per day ,which means 64 fl oz, or 1.89 litres(EPA ,2000-5; Cleveland Clinic, 2007). It is therefore suggested that regular monitoring of heavy metals in drinking water and also food items should be performed in order to prevent excessive buildup of these heavy metals in the human food chain. Heavy metals have a toxic impact, but detrimental impacts become apparent only when long-term consumption of contaminated water occurs. Because of the drinking water is not alone source of dietary heavy metals, certain groups of consumer such as elderly with cardiovascular problems and kidney deficiency who may intake these items for long term should be extra cautions as they are more susceptible to toxicities.

We suggest that some projects should be done to improve the operational efficiency and financial sustainability of provincial groundwater,due to improve water distribution systems. Public Health and Environmental Department in Ahvaz , Khuzestan and other provinces should be established due to detecting contaminant contents in tap water .The infected hand pumps and tube wells, which were being used for domestic usages in the Lead / Mercury contaminated areas, have been identified and put into hold for further usages **.**

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