ARTICLE

HEAVY METAL CONCENTRATIONS IN WATER RESOURCES OF RURAL AREAS OF KERMANSHAH, IRAN

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ABSTRACT

The main cause of many health problem, in the developing countries, still is lack of access to hygienic water resources. Water resources contaminated by heavy metals is one of the serious environmental concerns of the recent decades. The present study is an attempt to survey concentration of heavy metals such as chrome, manganese, and copper in water resources of rural areas of Kermanshah Province. The study was carried out as descriptive and cross-sectional work to determine concentrations of chrome, manganese, and copper in water resources of rural areas of Kermanshah Province. The data was compared with Iran National Standard (1053). The samples were examined by atomic absorption spectrophotometry to determine concentration of the contaminations. The obtained data was analyzed in SPSS-16. The results showed that MEAN concentrations of chrome, copper, and manganese were 0.44, 0.195, and 0.24 respectively, which were in compliance with Iran National Standards. In addition, concentration of copper and manganese in all the samples met the standards. As to chrome, 2.5% of the samples did not meet the standards. Mean concentrations of the metals in the present study was in compliance with Iran National Standard and the samples were safe for drinking. However, given the critical importance of routine survey of water resources in rural areas, the local officials need to examine the resources in routine bases.

KEY WORDS
Heavy metal, concentrations, chrome, copper, manganese, Kermanshah

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INTRODUCTION

According to the definition by World Health Organization [WHO], drinkable water is the water that is suitable for consumption by human and all other household usages [1]. Developing countries are still challenged by the health problems caused by unhygienic water; this is indicated by the statistics of WHO [2]. What is the main concern for human communities is contamination of the environment by heavy metals, which is a serious problem as these metals, even at low concentration levels, are not absorbable, induces physiological effects, and influence living organisms [3-6]. The contamination of water resources by heavy metals is one of the main environmental problem of the recent decades [7-8]. Heavy metals are featured with high chemical stability, low decomposability, and augmentation in the body of living organisms; these make them a serious health problem in today's industrial world [9, 10]. Contamination of water resources by heavy metals happens through natural ways [weathering and erosion of rocks] and human's activities [mining, industrial activities, and farming]. These factors degrade quality of water resources for drinking, farming, and industrial purposes [8 ,11]. One of the main issues caused by the water contaminated by heavy metals is failure of metabolization these metals in the body, so that they are augmented in fat, muscles, bone, and joints tissues and cause variety of disease and side-effects [1]. In general, human environment is featured with 35 toxic metals and 23 of them are heavy metals. These metals are naturally found in small quantities in food regimen so that they are needed for good health. However, when concentrations of these metal exceed the natural level, they induce toxic effects on human body [12 ,13]. Chrome is one of the main elements needed for carbohydrates and fats metabolism. The element also increases sensitivity to insulin through facilitating insulin attachment to cells and increasing number of insulin receivers. Chrome shortage increases risk factors of different diabetes, cardiovascular diseases, and disorders of immunity system [14]. The side-effects of excessive intake of chrome appears as rush, burning and itching in digestive system mucus membranes, and in serious cases, as the liver

necrosis, the kidney inflammation, internal bleeding, respiratory problems, digestive system cancer, and death [15]. Manganese can have severe toxic effects on different body organs such as liver. It induces respiratory, digestive, and nervous poisoning; and the latter is known as manganism with symptoms similar with Parkinson's disease [3]. Copper is the third mostly used metal in the world and also one of the critical micronutrients for animals and plants. The elements are needed for hemoglobin production in human, and in plants, it is needed for reproduction, fighting diseases, and regulating water [16]. However, excessive amounts of this metal can cause anemia, liver, renal, digestive, and nervous disorders [17]. Results of a study to survey concentration of manganese in ground water in Scotland showed that 30% of the water resources were contaminated with the elements [based on WHO standards] [18]. Sobhani Ardakani surveyed concentrations of arsenic, zinc, chrome, and manganese in ground water resources in Razan Plain and reported that mean concentrations of the elements met the standards of WHO [3]. Alidadi et al surveyed concentrations of heavy metals [chrome, cadmium, and lead] in drinking water of Mashhad City and showed that concentrations of chrome and cadmium were less than national and international standards and concentration of lead was higher than the standards in some regions. In addition, mean concentrations of the elements in summer and spring were significantly different [4]. Ahmadizadhe Finit studied concentrations of cadmium, lead, and zinc in water resources of villages of Bandar Abbas and showed that mean concentrations of the metals in drinkable water wells was as per the standards. However, concentration of cadmium in 52% of the samples was higher than WHO standards [1]. Pieri measured concentrations of nickel, aluminum, copper, and manganese in water resources of Zabol and reported that except nickel, concentrations of all metals was below the standard levels [3]. Concentrations of heavy metals in drinking water is highly effective on quality of the water and controlling concentrations of these metals in water resources is highly critical; these highlight necessity of periodical studies in this field [1]. Given the importance of the issue, the present study is aimed at measuring concentrations of chrome, manganese, and copper in drinking water resources of rural areas of Kermanshah Province, Iran.

MATERIALS AND METHODS

A descriptive cross-sectional study was carried out to determine concentrations of heavy metals (chrome, manganese, and copper) in drinking water resources in rural areas of Kermanshah Province based on Iran National Standards. Totally, 153 specimens from 51 villages were collected. Having made the arrangements and educated the health personnel in rural clinics, the specimens (water taps, wells, and reservoirs) were collected in special containers. The specimens were transported to the lab following the national guidelines and the standards. The samples were collected in polyethylene containers (0.5L), which were rinsed in the labs beforehand. The specimens were collected according to the sampling instructions (3). In addition, PH of the samples was measured at site using ph-meter. The specimens were examined using atomic absorption spectrophotometry in Kermanshah Medical Science University by experienced personnel. The collected data was analyzed

RESULTS

The results of the study are listed in [Table 2 and 3]. Value of pH in none of the samples under study was higher than the standard levels. In addition, concentrations of copper and manganese in all the samples were at the standard range. As to chrome, although, mean concentration of the metal was within the standard limits, however, in two cases (Mahmoudabad-Jouzi) concentration of the metal was higher than standard levels.

Table 1: Quality Assessment of drinking water in terms of heavy metals

Variable	Preferred level (mg/li)	Permitted level (mg/li)
PH	65-8.5	6.5-9
Chrome	-	0.05
Copper	1	2
Manganese	0.1	0.4

Table 2: Mean and SD value of concentrations of heavy metals

Variable	Mean	Std. Deviation	Minimum	Maximum
PH	7.4	0.3	6.7	8
Chrome	0.044	0.023	0.04	0.16
Copper	0.195	0.07	0	0.501
Manganese	0.24	0.11	0	0.72

Table 3: Concentrations of heavy metals in drinking water based on place of sampling

City	Place of sampling	pH	Chrome	Copper	Manganese
Paveh	Satiari	7.4	≤0.04	0.293	0.153
	Nouryab	7.8	≤0.04	0.501	0.185
	Sheler	7.4	≤0.04	0.279	0.191

	Banehvareh	7.5	≤0.04	0.31	0.22
	Chourzi	7.4	≤0.16	0.307	0.143
Harsin	Karmiang	7.8	0.04	0.178	0.43
	Tamarg	8	0.04	0.181	0.72
	Legz	7.2	0.04	0.155	0.12
Songhor	Ghrianch	8	0.04	0.257	0.172
	Heibatollah	7.2	0.04	0.161	0.303
	Deh Solieman	7.2	0.04	0.155	0.242
Islam Abad	Ghoveh Sorkhak	7.6	0.04	0.149	0.271
	Chahardah Jofteh	7.4	0.04	0.223	0.149
	Dizgaran	7.4	0.04	0.149	0.185
	Chenger	7.4	0.04	0.209	0.326
Sahne	Guilaneh	7.3	0.04	0.147	0.069
	Cheraghabad	7.4	0.04	0.169	0.297
	Ab Barik	7.4	0.04	0.176	0.333
	Chah Moieneh	7.6	0.04	0.138	0.294
Dalahou	Ghale Zanjir Sofla	7.6	0.04	0	0
	Kachal Bel Olia	7.2	0.04	0.243	0.194
	Houkani	7.8	0.04	0.236	0.284
	Rijab	7.3	0.04	0.22	0.227
Ravansar	Routvand	7.8	0.04	0.184	0.345
	Lohrabi	7.8	0.04	0.144	0.384
	Hassan Abad	7.8	0.04	0.231	0.361
Kermanshah	Helshi	7.2	0.04	0.156	0.148
	Mahidasht Shahr	7.6	0.04	0.245	0.233
	Abbass Abad	7.5	0.04	0.212	0.249
	Markaz Ghazanchi	7	0.04	0.198	0.313
	Rahimabad	8	0.04	0.147	0.214
	Kashanbeh	7.6	0.04	0.248	0.191
	Bijteh	8	0.04	0.268	0.221
	Haft Cheshme	7.6	0.04	0.24	0.259
	Cheghablak	7.6	0.04	0.192	0.225
	Mahmoud Abad	7.1	0.16	0.175	0.328
Javanroud	Sarab Bas	6.9	≤0.04	0.147	0.297
	Nahrab	7.8	0.04	0.152	0.162
	Sefid Barg	7.8	0.04	0.148	0.12
Kangavar	Ali Abad	7.6	0.04	0.138	0.373
	Rahman Abad	7.6	0.04	0.172	0.175
	Gharlogh	7	0.04	0.152	0.201
Guilan Gharb	Cheshme Gholami	7.5	0.04	0.158	0.127
	Viznan	6.7	≤0.04	0.248	0.259
Sarpol zahab	Piran	7	≤0.04	0.248	0.179
	Sraileh	7.6	≤0.04	0.147	0.287
	Habivand	7.6	≤0.04	0.161	0.246
	Gharebagh	7.5	≤0.04	0.221	0.24
	Gavchali	7.8	≤0.04	0.141	0.236
Salas Babajani	Miraabad	7.4	0.04	0.152	0.085
Ghasr-e-Shirin	Cheshmeh Imam Hassan	7.1	0.04	0.133	0.316

Heavy metals have become a health issue in the today's industrial world. These metals can enter human body from different paths. They play two key role in the body; i) being part of the ingredients of vital molecules; and ii) being coenzymes so that by attaching to different enzymes they can activate the enzyme and accelerate the reactions. Therefore, some of metals are needed and useful for living organisms. Lack of some of these metals delays natural body reactions and induces negative physical responses in the body [20]. Different factors influence available amounts of these metals in the ecosystem. Heavy metals can enter urban, industrial, and agricultural sewage by natural forces (e.g. soil erosion and flood) or unnatural factors such as human activities [21]. The results showed that mean concentrations of copper and manganese were at the Iran National Standard range. In the case of chrome, while mean concentration of the metal was at the standard range, in two cases (Mahmoud Abad and Jourzi) concentration of the metal was higher than the standards. The results also showed that pH of the samples ranged from 6.7 to 8. This range in Sobhani Ardakani work was 7.1-8.2. This pH range decreases reactivity of the elements and increases their adsorption by soil colloids. In addition, this pH range facilitates solvability of positive metal ions (metal elements such as arsenic, zinc, and chrome), creates alkali specifications in water, and increases pH value above 7 (3). According to Iran National Standard 1053 maximum acceptable concentration of chrome in drinking water is 0.05mg/L and mean concentration of chrome in this study was 0.04. Malakoutian et al. studied ground water resources in Sirjan Plain and showed that mean concentration of chrome was less than 1mg/L [22]. Basma Yaghi (2007) surveyed concentrations of heavy metals in 364 private wells in Batinai region, Oman and showed increase of lead and chrome above the standards in 80% of the wells. The causes of the contaminations were namely industrial activity in the region and erosion of rocks in the region due to the climate [23]. Maximum acceptable concentration of copper in drinking water according to Iran standard (1053) is 2 mg/L and our results showed that this figure was 0.195mg/L, which is far less than the standard requirement. Malakoutian reported that mean concentration of copper in ground water resources was 26.74µg/L, which was acceptable according to the standards [22] Alighadr et al. studied concentrations of heavy metals in

drinking water reservoirs in Ardabil and found that concentration of Iron in all samples was less and within the standard range and concentration of copper was at the top limit of the national standard (24). In addition, Rajaie et al. surveyed concentrations of heavy metals in water wells of Sistan Balouchestan Province and showed that concentrations of copper and iron were within the standard range and safe for drinking [25]. Aker et al. (2006) measured concentrations of copper, cadmium, and lead in running water of Mytilu SP region. Their results indicated that concentrations of these metals vary in time; so that concentration of cadmium was low and concentrations of copper and lead were higher [26]. Hassanzadeh et al. surveyed concentration of heavy metals (lead and copper) in ground water reservoirs of Kerman City and concluded that concentrations of these metals was at the standard range [27]. According to Iran National Standard (1053), maximum allowable concentration of Manganese in drinking water is 0.4mg/l and our results showed that concentration of this metal was 0.24mg/L. Sobhani et al. reported concentration of Manganese was 4.50 parts in one billion part, which is far less than the standard limit [28].

CONCLUSION

The results showed that the concentration of chromium except two points in suburb of Kermanshah and Paveh were higher than national standard (0.16). And according to the carcinogenic characteristic of hexavalent chromium and genetic damage caused by trivalent chromium, some measures must be done in this field. In other cases, the concentration of chromium was in standard range. About the copper and manganese parameters, all the samples were lower than the national standard threshold and allowable to drink. But since the displacement and metals washing by water is inevitable over the time, however, regular monitoring of drinking water for rural areas is really necessary by relevant authorities.

CONFLICT OF INTEREST
There is no conflict of interest.

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