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Lead and Chromium Concentrations in the Potable Water of the Eastern Province of Saudi Arabia

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Many studies of lead in drinking water have been conducted in the United States and the United Kingdom during the past decade. Beattie et al. (1972) demonstrated that the presence of lead in drinking water has been found to be in association with lead piping in the water supply system. Addis and Moore (1974), Covel (1975) and Moore (1975) have reported significantly higher levels of lead in blood of people living in households having lead water pipes, and that these levels were related to levels of lead in the water.

Lead toxicity is very wide-ranging and include impared blood synthesis, hypertension, hyperactivity, brain damage, chronic nephritis and renal sclerosis.

Chromium may be present in water in the hexavalent (chromate) or trivalent form, but trivalent chromium rarely occurs in potable water. Hexavalent chromium enters water supply system through industrial waste from industries where chromate is used to inhibit metal corrosion. Chromium is an objectionable contaminant in drinking water due to its suspected carcinogenic effects.

The World Health Organization (WHO) and United States Public Health Service (USPHS) standards for drinking water recommend an upper limit concentration of 0.05 mg/L for both lead and chromium. Mustafa et al. (1988) studied the cadmium and zinc concentrations in the potable water of the Eastern Province of the Kingdom of Saudi Arabia. We report here the results of the study of lead and chromium concentrations in the potable water of the same area to provide a more complete profile of of the levels of heavy metals in the potable water of the Eastern Province.

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MATERIALS AND METHODS

In 1984 and 1985 three hundred and eight water samples were collected from seven major population areas of the Eastern Province: 41 from Qatif, 50 from Jubail, 52 from Dammam, 149 from Hasa, 5 from Khobar, 6 from Hafer Al-Batin and 5 from Khafji. All samples were stored at $4^{\circ}C$ until analyses were performed. Lead was analyzed by flame atomic absorption spectrophotometry according to the method of Brown (1968) and chromium by spectrophotometry using the APHA standard 1,5-Diphenylcarbohydrazine method.

RESULTS AND DISCUSSION

Results of lead and chromium concentrations in the 308 water sampling sites are recorded in Tables 1 and 2, and their concentration distributions in the major seven population locations of the Eastern Province in Tables 3 and 4.

Table 1 indicates that 288 water samples, or 93.5%, of the 308 analyzed for lead are below the WHO and USPHS limits for this element, and 20 samples, or 6.5%, exceed the upper limit of 0.05 mg/L. Eight of these samples, or 2.6%, were located in Dammam and 5 samples, or 1.6%, in Jubail.

A survey of the water sampling locations, especially those with lead concentrations above the limit, indicated that these samples, particularly in Dammam and Jubail, were taken either from coolers or wells where lead or lead-lined service pipes were used.

As for chromium concentrations in water (Table 2), and distribution in the seven major population locations (Table 4), it was found that 259 samples, 84.1%, were below the WHO and USPHS limit of 0.05 mg/L, and 49 samples, or 15.9%, located mainly in Hasa and Dammam, were above the limit.

While it is easy to explain the presence of industrial discharge leading to elevated chromium levels in water in Dammam, a metropolis with major industrial activities, an acceptable culprit cannot be found to explain the presence of chromium at elevated concentrations in Hasa, a city with few industries and extensive cultivation.

Table 1. Lead concentrations in water sampling locations

Pb CONC. (mg/L)	No. OF SAMPLES INT.	CUM.	PERCENTAGE INT.	CUM.
0.005	45	45	14.6	14.6
0.010	44	89	14.3	28.9
0.015	54	143	17.5	46.4
0.020	32	175	10.4	56.8
0.025	30	205	9.7	66.6
0.030	24	229	7.8	74.4
0.035	23	252	7.5	81.8
0.040	25	277	8.1	89.9
0.045	11	288	3.6	93.5
0.050	5	293	1.6	95.1
0.055	4	297	1.3	96.4
0.060	2	299	0.6	97.1
0.065	4	303	1.3	98.4
0.070	2	305	0.6	99.0
0.075	1	306	0.3	99.4
0.085	1	307	0.3	99.7
0.100	1	308	0.3	100.0

Table 2. Chromium concentrations in water sampling locations

Cr CONC. (mg/L)	No.OF SAMPLES INT.	CUM.	PERCENTAGE INT.	CUM.
0.005	113	113	36.7	36.7
0.010	29	142	9.4	46.1
0.015	2	144	0.6	46.7
0.020	1	145	0.3	47.1
0.025	54	199	17.5	64.6
0.030	7	206	2.3	66.9
0.035	16	222	5.2	72.1
0.040	2	224	0.6	72.7
0.045	35	259	11.4	84.1
0.050	23	282	7.5	91.6
0.055	6	288	1.9	93.5
0.065	2	290	0.6	94.2
0.070	1	291	0.3	94.5
0.075	8	299	2.6	97.1
0.095	1	300	0.3	97.4
0.100	1	301	0.3	97.7
0.135	1	302	0.3	98.0
0.185	2	304	0.6	98.7
0.200	4	308	1.3	100.0

Table 3. Distribution of lead concentrations in different water sampling locations

Location	Qatif	Jubail	Dammam	Hasa	Khobar	H.Batin	Khafji
Mean Con.	0.022	0.031	0.033	0.014	0.003	0.013	0.004
Std.Dev	0.012	0.020	0.018	0.008	0.003	0.006	0.003
R.E.S.D.	0.012	0.018	0.017	0.008	0.003	0.005	0.003
S.E.M.	0.002	0.003	0.002	0.001	0.001	0.002	0.001
Maximum	0.049	0.095	0.071	0.037	0.007	0.017	0.007
Minimum	0.002	0.000	0.001	0.000	0.000	0.002	0.000
Samp.size	41	50	52	149	5	6	5

Table 4. Distribution of chromium concentrations in different water sampling locations

Location	Qatif	Jubail	Dammam	Hasa	Khobar	H.Batin	Khafji
Mean Coc.	0.021	0.011	0.019	0.048	0.002	0.046	0.009
Std.Dev	0.010	0.009	0.014	0.089	0.001	0.087	0.009
R.E.S.D.	0.009	0.009	0.014	0.040	0.001	0.080	0.009
S.E.M.	0.004	0.001	0.002	0.008	0.001	0.035	0.004
Maximum	0.033	0.040	0.053	0.910	0.004	0.220	0.024
Minimum	0.005	0.000	0.000	0.000	0.000	0.000	0.000
Samp.size	41	50	52	149	5	6	5

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REFERENCES

Beattie AD et al. (1972) Environmental lead pollution in an urnan soft water area, Brit.Med.J. 1: 491 - 493

Addis G and Moore MR (1974) Lead level in the water of suburban Glasgow, Nature 252: 120 - 121

Covel B (1975) Lead content in household water in Edinburgh, Health Bull 33; 114 - 116

Moore MR (1975) Lead in Drinking Water and its Significance to Health, Drinking Water Quality and Public Health. Water Research Center

Mustafa HT, Hassan HMA, Abo-Melha A and Talaat I (1988) Cadmium and Zinc Cocentrations in the Potable Water of the Eastern Province of Saudi Arabia, Bull.Environ. Contam.Toxicol. 40: 462 - 467

American Public Health Association, Washington, D.C., (1971) Standard Methods for Examination of Water and Waste Water, 13th ed.

U.S. Dept. of HEW, Public Health Service, (1962) Drinking Water Standard, Public Health Service Publ. 956, Washington, D.C.

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