An Investigation of Heavy Metal Contamination of Drinking Water in the City of Trondheim, Norway

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As the municipal water supply may be suspected to contain certain amounts of heavy metals, the authors have carried out a systematic study on this, using samples of drinking water taken from kitchen taps all over the city of Trondheim, and analyzing the samples by means of an atomic absorption spectrophotometer supplied with a carbon rod atomizer to increase the sensitivity.

Materials and Methods

About 600 samples of water were collected in 18 selected parts of the city of Trondheim. From each house or apartment, we collected three samples, one sample of hot water from the hot water heater, one sample of cold water stored in the tap for several hours, and one sample of running cold water. The samples were collected in 250 ml polyethylene bottles, and the analyses were performed the same day. The reason for taking three different kinds of sample from each house was, of course, to get information on the contaminating effect of storing the water in the tap or in the water heater. We tried to get samples from different kinds of buildings, from block houses, from single family houses, from newbuilt houses with modern equipment, and from old houses in the center of the city with old, presumably corroded, iron pipes and brass taps. Each sample was analyzed for copper, zinc, cadmium and lead by flameless atomic absorption spectrophotometry (L'VOV 1970).

Instrumentation

The instrumentation was based on a Hilger & Watts H 1170 Atomspek Spectrophotemeter, with a Philips PM 8100 recorder. The burner was replaced by a Varian Techtron Mod 63 Carbon Rod Atomizer. The power unit for the carbon rod can operate the carbon rod in three cycles, drying,

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ashing and atomizing, each preselected by two controls, one for setting the duration of the cycle, and one for selecting the applied voltage. When analyzing water samples the ashing step is omitted. The carbon rod is clamped between two water-cooled terminals, and nitrogen gas is used as a sheathing medium.

Standard solutions were made by diluting stock solutions. By setting the instrument parameters to the same fixed values, the stability was so good that the same calibration curve could be used for a period of several weeks within an error of less than 10 percent. In cases where this accuracy is sufficient, the analyzing procedure is simplified a great deal.

To get numerical values of the concentrations, the calibration curve was approximated by a 5th order polynomial, using a Wang 700 B calculator. The error function was also programmed into the calculator so, when feeding the numerical value of the recorder deflection into the calculator, the numerical value of the metal concentration was automatically obtained as well as the error of the result.

This instrumentation makes analysis on that kind of samples very easy to perform. Samples of 5 microliters are placed in the carbon rod by a syringe with a plastic tip, and in a few seconds the result is given as a recorder deflection.

Water samples can be analyzed without any preparation and, for the metals we were investigating, the sensitivity was in the region of 0.1 to 1 part per billion. For zinc it was as low as 0.01 part per billion. For control it is very easy to run parallels.

Results and Comments

When regarding the results as a whole, they are quite satisfactory with regard to public health implications of the findings. Table 1 gives the concentrations in ppb, with standard deviation in parentheses. This standard deviation is not to be confused with the error or the measured values; it indicates, of course, the variance of the samples.

Cadmium was detected in so few samples that it would be meaningless to give an average value.
Most frequently Cd was detected in cold water stored in the tap and, as the table shows, the tap is also the main source for zinc. The highest values of lead are found in hot water, and the table also indicates that

the heater is the main lead source. It is interesting to look at the mean values for seven old houses in the city center and compare them to the mean values for eight recently built single-family houses in a suburban street.

TABLE 1

	Zn	Cd	Cu	Pb
	ppb	ppb	ppb	ppb
Maximum conc. detected	2125	8.6	1100	110
Mean value for cold water stored in tap	348 (327)		164(155)	9.7(14)
Running cold water	126 (184)		52(79)	2.7(3.6)
Hot water from heater	130 (107)		209(215)	21 (25)

TABLE 2
Mean values for seven old houses in the city center

	Zn	Cd	Cu	Pb
	ppb	ppb	ppb	ppb
Cold water stored in tap	296	<	110	9
Running cold water	108	<	34	0.12
Hot water from heater	241	<	377	33

TABLE 3
Mean values for eight recently built houses

	Zn	Cd	Cu	Pb
	ppb	ppb	ppb	ppb
Cold water stored in tap	110	0.2	276	4
Running cold water	20	0.07	195	3
Hot water from heater	14	0.08	366	4

This indicates that modern houses have considerably higher values of lead, copper and cadmium in the running cold water, and much less zinc.

It is also of interest that old houses with old water heaters had a much higher lead concentration in the hot water. Here we also noticed a diluting effect; the lead concentration in hot water from heaters from the same factory varied according to the volume of the heaters. For heaters from a certain factory the mean value of lead in hot water was 46ppb for 20 liter heaters, while 100 liter heaters from the same factory showed a mean value of lead of 15 ppb. The cadmium concentration was similarly reduced from 0.2 to 0.08 ppb.

Samples taken directly from the different water reservoirs in the surroundings of Trondheim contained much smaller amounts of heavy metals than the samples taken from kitchen taps. As an example, the maximum value of cadmium found in these samples was 0.6 ppb.

Conclusion

The analytical method described is very useful for quantitative determination of heavy metals in water samples.

The concentrations of Zn, Cd, Cu and Pb in domestic water in Trondheim are relatively small, and apparently constitute no reason for concern with regard to their public health implications; however one should be careful about using water from the heater in food preparation.

A few samples showed extraordinarily high values of lead due to local sources in pipes and heaters. The persons concerned have, of course, been informed.

Acknowledgement

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Literature Cited

1. B.V. L'VOV: Atomic Absorption Spectrochemical Analysis 1970. Adam Hilger Ltd., London.