



Chromium (VI) speciation through the environment

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Speciation analysis yields information on the individual concentrations of the various chemical forms of a particular element in environmental samples. The interest in chromium speciation originates from widespread use of this metal in various industries such as metallurgical, refractory and chemical. Due to these industries large amount of chromium compounds are discharged in to the environment.

The two common oxidation states of chromium present in the environment, i.e. Cr(III) and Cr(VI), are greatly different. Cr(III) is considered a trace element essential for the proper functioning of living organisms, and is sparingly soluble. Cr(VI), on the other hand, exerts toxic effects on biological systems, and is usually highly soluble, mobile and bioavailable. It has been found that occupational exposure to Cr(VI) can cause a variety of clinical problems, such as asthma, bronchitis, inflammation of the liver and increased incidences of lung cancer.

Cr determination in analytical chemistry has undergone considerable changes in the last two decades. Many analytical techniques

have been set up in an effort to quantify the various Cr forms present in the natural environment. In this study, we made use of a simple and in-expensive ion-exchanger as means of separation of Cr(VI); where Cr(III), present as a cation, is retained on



Table 1: Efficiency of the cation exchange cartridge, determined by spiking samples with Cr(III) and/or Cr(VI). Cr in the samples is determined as Cr-tot using a ICP-HR-MS after either passing the sample through the cation exchange cartridge or not.

	With IC-column	Without IC-column
Buffer solution (no Cr added)	94 ng/l	75 ng/l
1000 ng/l Cr(III)	150 ng/l	950 ng/l
1000 ng/l Cr(III) + Cr(VI)	1103 ng/l	1950 ng/l
1000 ng/l Cr(VI)	1092 ng/l	978 ng/l
Marine sediment (no Cr added)	195 ng/l	234 ng/l
1000 ng/l Cr(III)	204 ng/l	226 ng/l
1000 ng/l Cr(III) + Cr(VI)	1145 ng/l	1076 ng/l
1000 ng/l Cr(VI)	1186 ng/l	1017 ng/l

Table 2: Comparison of results from this study and literature values.

	This study			Literature values	
	Cr(VI) DL*	Cr(tot) DL*	n [†]	Cr(VI)	Cr(tot)
Precipitation	282±180 ng/l 11 ng/l	1036±1672 ng/l 40 ng/l	9	30-100 ng/l	200-1000 ng/l
Natural waters	226±218 ng/l 6 ng/l	290±310 ng/l 40 ng/l	7	0-30000 ng/l (2, 3)	0-40000 ng/l (2, 3)
Ambient air	0.42±0.77 ng/m ³ 0.015 ng/m ³	10±20 ng/m ³ 0.015 ng/m ³	11	0.2-1.3 ng/m ³	<0.2-70ng/m ³
Human urine	0.5±0.1 ng/l 0.4 ng/l	0.9 ng/l 0.9 ng/l	6	N/A [‡]	0.2-2.0µg/l (4)
Fisk muscle	3.8±0.6 ng/g 1.6 ng/g	6.2±4.2 ng/g 1n6 ng/g	3	N/A	30-2000 ng/g (2)
Soil	44, 1.37 ng/g 7.0 ng/g	87±80 µg/g 0.02 µg/g	9	5-50*10 ⁶ ng/g	25-85 µg/g (5)
Sediment	36±58 ng/g 1.3 ng/g	10±9.7 µg/g 0.005 µg/g	6	0-2000 ng/g (6)	19-130 µg/g
Sludge	11±4 ng/g 3.9 ng/g	8±5.5 µg/g 0.021 µg/g	6	34 µg/g (7)	2000 µg/m (7)

* DL – Detection limit for the different environmental matrixes. † n – number of samples § N/A – Not Available

the ion-exchanger whereas Cr(VI), present as an anion, is passed to the effluent (1). This method was developed as a simple field method for Cr(VI) speciation in natural waters. However, we tested the method by spiking MilliQ water and a marine sediment with Cr(III) and Cr(VI) (table 1), and the results showed that the method is suitable for Cr(VI) speciation in a wide range of environmental samples, such as precipitation, soil, sediments, sludge, biological tissue and air samples.

Extraction of Cr(VI) in solid samples, air filters and urine:

Up to 2 g of sample material or ½ air filter was mixed with 50 ml 12.5 mmol bi-carbonate buffer. The samples were placed in an ultrasonic bath for 30 minutes, followed by filtration through a 0.45µm nylon syringe filter. Cr(VI) was extracted from the sample by forcing the sample through the cation-exchange cartridge (fig 1). Ion-exchange is followed by determination with ICP- HR-MS.

Cr-tot was determined by ICP-HR-MS after sample digestion in 3:5 H₂O₂:HNO₃ in a microwave oven.

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