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DETERMINATION OF As^{3+}, Sb^{3+} AND Se^{4+} METAL IONS IN DRINKING WATER USING HG-ICP-EOS TECHNIQUE

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Introduction

The abundance of metals in drinking water can have adverse effects on human health. Supply safe drinking water is an important factor in preventing the transmission of diseases through water. Therefore continuous monitoring of drinking water quality is essential. Metals that have been detected in potentially harmful concentrations in drinking water systems are caused by industrial pollution, anthropogenic pollution or as a result of corrosion processes of the component materials of drinking water supply networks.

European Directive on drinking water 98/83/EC, transposed into Romanian Legislation in the form of Law No. 458/2002 updated by Law No. 311 of 2004, imposes 10 µg/L as concentration limit for arsenic in water intended for human consumption, 5 µg/L for antimony and 10 µg/L for selenium.

Drinking water and mineral water can be contaminated with toxic metals, such as: antimony, by degradation of polyethylene terephthalate (PET) used in the composition of plastic bottles, due to damage processes and due to improper storage. Antimony possesses a risk to human health, affecting the respiratory, cardiovascular, gastrointestinal, dermal and reproductive systems.

The presence of arsenic in drinking water is due to both groundwater and surface water contamination through discharges of industrial effluents containing arsenic.

Arsenic (As^{3+}, As^{5+}) causes skin damage, circulatory and peripheral nerve disorders. Selenium is toxic only in large quantity, its presence in drinking water being mainly related to mining activities and industrial emissions.

Usually, these volatile metalic elements are found in low concentrations, and their determinations require the use of sensitive analytical techniques. Their detection can be done using spectrometry UV-VIS, AAS, HG-AAS, ICP-EOS, HG-ICP-EOS, ICP-MS and HG-ICP-MS.

Materials and methods

The experimental study was performed with an inductively coupled plasma optical emission spectrometer ICP–EOS AVIO 500 Perkin Elmer and a FIAS 400 Perkin Elmer automatic flow injection system for hydride generation. The hydride generation technique involves the reaction of acidic aqueous solutions (HCl 10%), containing volatile metal ions As^{3+}, Sb^{3+} si Se^{4+} with a reducing agent (0.2% $NaBH_4$ in 0.05% NaOH). For the experimental study following reagents and chemicals were used: sodium borohydride purum, ≥96%; sodium hydroxide puriss ≥ 98%, pellets; potassium iodide puriss 99-100.5%; L-Ascorbic acid puriss 99.7-100.5% (Sigma-

Aldrich); hydrochloric acid 37%; nitric acid ultrapure grade 69% (Merck). For the calibration curve were used, Certified Reference Materials (CRM) Arsenic standard, Antimony standard, Selenium standard for ICP, 1000 mg/L (Sigma-Aldrich) and a Reference Material (RM) Quality Control Standard 21, 100 mg/L (LGC).

Results and conclusions

Table 1 presents some instrumental and performance parameters of the applied analysis methods (detection limit LOD, quantification limit LOQ). After calculating the performance parameters for the As^{3+}, Sb^{3+} and Se^{4+} in drinking water, it was found that at these wavelengths the lowest detection limit was obtained.

Table 1. Instrumental and performance parameters of the applied methods

Element	λ (nm)	LOD (µg/L)	LOQ (µg/L)
As^{3+}	188.979	0.13	0.43
Sb^{3+}	217.582	0.35	1.18
Se^{4+}	196.026	0.42	1.40

In the study were analyzed 20 water samples from different sources, respectively tap water, groundwater and mineral water (table 2).

Table 2. Types of samples analyzed and location

Sample code	Description	Sample code	Description
TW_1	Tap water, Bucharest	TW_{11}	Tap water, Timis
TW_2	Tap water, Bucharest	TW_{12}	Tap water, Olt
TW_3	Tap water, Timis	GW_1	Groundwater, Bucharest
TW_4	Tap water, Prahova	GW_2	Groundwater, Olt
TW_5	Tap water, Bucharest	GW_3	Groundwater, Prahova
TW_6	Tap water, Bucharest	GW_4	Groundwater, Timis
TW_7	Tap water, Arges	GW_5	Groundwater, Timis
TW_8	Tap water, Ilfov	MW_1	Mineral water, Prahova
TW_9	Tap water, Bucharest	MW_2	Mineral water, Ilfov
TW_{10}	Tap water, Arges	MW_3	Mineral water, Bucharest

Table 3. Arsenic, antimony and selenium concentration in different types of water, µg/L

Sample ID	As^{3+}	Sb^{3+}	Se^{4+}	Sample ID	As^{3+}	Sb^{3+}	Se^{4+}
TW_1	<0.43	1.81	1.52	TW_{11}	<0.43	<1.18	<1.40
TW_2	<0.43	<1.18	<1.40	TW_{12}	2.23	<1.18	<1.40
TW_3	6.13	1.73	<1.40	GW_1	<0.43	<1.18	<1.40
TW_4	<0.43	<1.18	<1.40	GW_2	<0.43	1.33	1.63
TW_5	<0.43	<1.18	<1.40	GW_3	7.21	4.33	<1.40
TW_6	<0.43	2.44	1.90	GW_4	0.83	<1.18	2.01
TW_7	0.53	1.84	<1.40	GW_5	4.23	<1.18	1.63
TW_8	1.23	<1.18	1.41	MW_1	<0.43	2.31	<1.40
TW_9	<0.43	1.72	1.64	MW_2	1.42	2.42	<1.40
TW_{10}	9.20	<1.18	<0.42	MW_3	<0.43	2.21	<1.40

The obtained results are presented in table 3. The values represent the mean of three determinations, all the analysed samples having results below the maximum admissible values according to in force legislation.