

Evaluation of inorganic arsenic species in drinking water of the southeastern of Buenos Aires province, Argentina.

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ABSTRACT: Arsenic in natural water is a worldwide concern due to chronic health effects in people exposed through the drinking water. The aim was to evaluate the distribution of As(III) and As(V), through ASV, in an Argentine area with low or absent information about these contaminant. The species of inorganic arsenic were quantified in groundwater, surface and drinking water, by Anodic Stripping Voltammetry (ASV) using a gold disc electrode. Total As was analyzed after the reduction step, calculated As(V) by difference. In some sites, total As values exceed the maximum limit for human consumption (10 µg/l), but the As(III)/As(V) ratio was significantly low. The lowest levels of total As were found in those sites related to possible anthropogenic activities, indicating that the content of it in the studied water is coming from natural environment. This study constitutes the first report of inorganic As speciation for the southeastern of Buenos Aires province.

1. INTRODUCTION

Arsenic is a natural contaminant. The inorganic As(III) is the most toxic species, and it is found in both surface and groundwater. As(III) is associated with reducing conditions (aquifers), while As(V) is encouraged by the atmospheric oxygen (surface water). Their presence in natural waters is of concern due to the disease caused by chronic exposure through drinking water (HACRE, Regional Chronic Endemic Hydroarsenicism). In Argentina, the HACRE is found in a wide geographic distribution. In 2006, the US EPA/WHO established a new maximum level in drinking water for total As (As_t), 10 µg/l. The aim was to evaluate the distribution of As(III) and As(V), through ASV, in an Argentine area with low or absent information about these contaminant. The use of this technique is advantageous due to its high sensitivity and the possibility of identifying species of As. The speciation is important in the selection and design of a treatment system (Sorg et al, 2013).

2. EXPERIMENTAL SECTION.

2.1 Sampling

Samples were taken from taps, domestic wells and system water, and from stream in the cities of Miramar, Mar del Sud and Otamendi. Polypropylene bottles were used, HCl added before and ascorbic acid added *in situ* to *posteriori* sampling to prevent oxidation of As(III). Hardness, alkalinity and dissolved oxygen were determined in lab; and temperature, salinity, pH and conductivity were measured *in situ* using a multiparameter analyzer.

2.2 As(III) and As(V) determination

Potentiostat POL 150 coupled to MDE 150 polarograph (Radiometer Copenhagen) with the software Trace Master 5 was used. Rotating gold disc (99.99%, area 0.030 cm²), Ag/AgCl and Pt wire as working, reference and counter electrode, respectively, were employed. The method applied was Square Wave Anodic Stripping Voltammetry (SWASV) (Bodewig et al, 1982). After the reduction with Na₂SO₃, As_t was determined, obtaining As (V) by difference (Rasul et al, 2002).

3. RESULTS AND DISCUSSION.

In all places, concentrations of As(III) were significantly lower ($p < 0.01$) than As(V) (Fig.1), whose percentages have been 1.5% - 16% in relation to As_t . Maximum values were 38.8 $\mu\text{g/l}$ for As_t , being 3.8 $\mu\text{g/l}$ of As(III) and 36.7 $\mu\text{g/l}$ of As(V). Both chemical species are shown the lowest mean concentrations in groundwater (close to the landfill) and surface water (stream) of Miramar; while the highest were found in groundwater of Mar del Sur and Otamendi cities. Despite this results, the differences were significant ($p < 0.05$) only for As(V), and not for As(III) ($p > 0.05$). It is noteworthy that the landfill area would not be a source to groundwater. Furthermore, the lower As(III) levels in the surface waters than groundwater, would be related to its high oxygen content (Table 1) (Sánchez-Rodas et al, 2005). The concentrations of As_t were higher than the maximum levels for drinking waters (10 $\mu\text{g/l}$; US EPA/WHO), with the exception of the sites close to landfill areas.

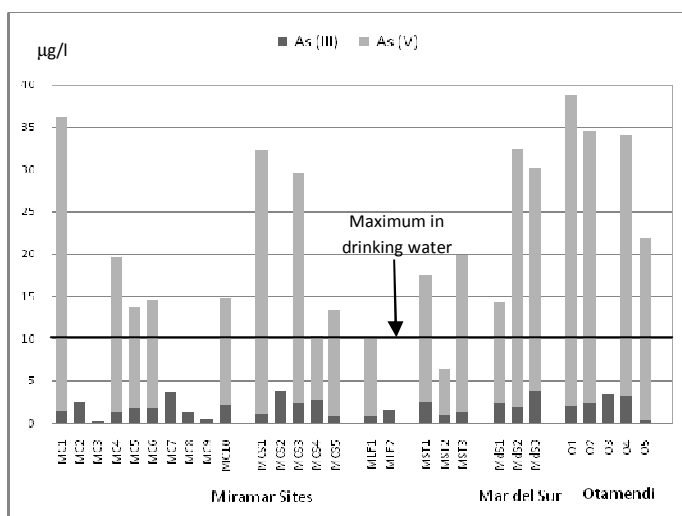


Figure 1. Concentrations ($\mu\text{g/l}$) of As(III) and As(V) in sampling sites from the southeastern of Buenos Aires province. MC: Miramar Downtown, MCS: Miramar Close to Stream, MLF: Miramar Landfill, MST: Miramar Stream, MdS: Mar del Sur, O: Otamendi

Cluster analyses (data not shown) indicated relationships among As(III) with conductivity, pH and dissolved oxygen. Similar results were found by Paoloni et al. (2009) in Pampa plains (Argentina).

| Parameters | | | | | |
|-------------------------|---------|-----------------------|----------------------|-----------------------------|---------------------------|
| Sites | pH | O ₂ (mg/L) | Conductivity (mS/cm) | As(III) ($\mu\text{g/l}$) | As(V) ($\mu\text{g/l}$) |
| Miramar Downtown | 7.5–8.8 | 3.5–6.6 | 1.6–2 | 0.3–3.8 | 11.9–34.7 |
| Miramar Close to Stream | 7.3–8.5 | 4.6–6.1 | 1.5–2 | 0.9–3.9 | 7.6–31.1 |
| Miramar Landfill | 7.4–8.6 | 6.3–6.5 | 1.6–1.7 | 0.8–1.6 | 9.2 |
| Miramar Stream | 7.5–7.7 | 8.1–9.9 | 1.4 | 1.0–2.4 | 5.5–18.6 |
| Mar del Sur | 8.4–9.4 | 4.5–6.7 | 1.8–1.9 | 1.9–3.8 | 2.6–30.6 |
| Otamendi | 7–8.3 | 1.2–5.9 | 0.6–1.3 | 0.3–3.4 | 21.5–36.7 |

Table 1. Environmental parameters, As(III) and As(V) concentrations in sampling sites from southeastern Buenos Aires province.

4. CONCLUSIONS

This work is the first report for As speciation in the study area. Beside of As values exceeding the maximum limit for human consumption (10 $\mu\text{g/l}$), the As(III)/As(V) ratio was significantly low. The obtained results were indicated that anthropogenic activities are not an As sources. The ASV was useful tool and could be recommendable for the speciation analysis. The information on As speciation would be used in future monitoring and remediation treatments.

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