ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

# Analysis of urine

## *Research summary*

ALS Scandinavia uses sector field inductively coupled plasma mass spectrometry (ICP-SFMS) for analysis of urine. Our research has shown that for the majority of the range of studied platinum group elements, sub-ng/l detection limits were enabled, and the method was found to be adequate at physiological levels. While both ICP-SFMS and ICP-QMS could be equally well applied in studied where elevated levels are to be expected, at the levels found in unexposed individuals only ICP-SFMS operated in HRM gives reliable results.

Urine samples collected from 19 non-smoking healthy subjects (12 males, 7 females, age range 11-48 y), living in Sweden, were analyzed by ICP-SFMS (1). None of them had any known occupational exposure to trace elements. Out of 42 elements included in the analysis, 23 were detectable in all samples and another 14 in the majority of samples.

In a later study, urine from 12 apparently healthy volunteers (6 males, 6 females), living in Sweden and covering the age interval 5-61 years (mean 31 y, S.D. 12 y), was analyzed (2). None of the subjects had any known exposure to trace elements.

All samples were analyzed after simple dilution 1+19 (1) or 1+9 (2) with 0.14 M high-purity nitric acid in distilled de-ionized water.

Examples of results from both studies are given in Table 1.

A later study (3) focussed on 20 rare elements (including platinum group elements). Certain instrumental modifications providing enhanced instrument sensitivity, together with the use of ultra-pure reagents, enabled sub-ng/l detection limits for 13 elements. Accuracy was assessed by means of samples from an intercomparison study. For 14 elements (Y, Zr, Nb, Sb, Hf, Ta, W, Re, Ir, Pt, Au, Tl, Bi and U), the method was found to be adequate at physiological levels. Three pooled samples, each representing 30-35 adults living in different parts of Sweden, were analyzed after dilution 1:9 with 2% hydrochloric acid. Some examples are given in Table 2. While high mass resolution was found to improve accuracy for light platinum group elements, it was concluded that quadrupole ICP-MS on the whole should yield essentially equivalent results for elevated concentrations (i.e. >0,5 µg/l).

**Table 1.** *Examples of elements in urine (ng/ml) from non-exposed subjects.*

| Element | Range[a] | Range[b] |
|---|---|---|
| Aluminium | <1.2–4.1 | 0.6–5.1 |
| Cadmium | 0.044–0.358 | 0.005–0.46 |
| Chromium | 0.06–0.26 | <0.04–0.30 |
| Cobalt | 0.06–0.51 | 0.04–0.81 |
| Lead | 0.3–2.0 | 0.12–2.9 |
| Manganese | <0.27–2.50 | <0.05–0.24 |
| Mercury | 0.22–2.00 | 0.14–4.2 |
| Nickel | 0.27–3.68 | 0.24–2.7 |
| Uranium | <0.0014–0.0174 | 0.0007–0.019 |
| Vanadium | 0.011–0.089 | 0.008–0.12 |

[a] *dilution 1+19, see reference (1)*
[b] *dilution 1+9, see reference (2)*

*Right solutions....*
*....Right partner*

**Table 2.** *Examples of elemental concentrations (ng/ml) in human urine (3 pools with 30-35 subjects in each).*

| Element | Range |
|---|---|
| Silver | 0.003-0.007 |
| Gold | 0.008-0.013 |
| Bismuth | 0.0008-0.0026 |
| Platinum | 0.0006-0.0011 |
| Rhenium | 0.006-0.014 |
| Antimony | 0.070-0.12 |
| Tantalum | 0.006-0.011 |
| Thallium | 0.049-0.13 |
| Uranium | 0.012-0.016 |
| Zirconium | 0.020-0.038 |

## References


*1. Rodushkin I., Ödman F., Application of inductively coupled plasma sector field mass spectrometry for elemental analysis of urine, J. Trace Elem. Med. Biol., 2001, 14, pp 241-247.*

*2. Rodushkin I. et al., Multi-element analysis of body fluids by double-focusing ICP-MS, Transworld Res. Network. Recent Res. Devel. Pure & Applied Chem., 2001, 5, pp 51-66.*

*3. Rodushkin I. et al., Determination of low-abundance elements at ultra-trace levels in urine and serum by inductively coupled plasma-sector field mass spectrometry. Anal. Bioanal. Chem., 2004, 380, 247-257.*