ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Analysis of serum
Research summary

ALS Scandinavia uses sector field inductively coupled plasma mass spectrometry (SF-ICP-MS) for analysis of serum. Here, some of the studies carried out by the ALS Scandinavia laboratory are summarized. It is shown that, for the majority of elements determined after dilution with nitric acid, ALS Scandinavia's ICP-SFMS results agreed well with previously published data. The analysis of a human serum reference material showed there were no differences in the results between material diluted with nitric acid and material prepared using microwave-assisted acid digestion.

Serum 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 (1). None of the subjects had any known exposure to trace elements. Following clotting, serum was separated by centrifugation and decanted.

The samples were analyzed after dilution (1+9) with 0.14 M high-purity nitric acid in distilled de-ionized water. The analysis was performed by Inductively Coupled Plasma Sector Field Mass Spectrometry (ICP-SFMS).

Out of 64 elements, 39 (including i.a. silver, antimony, tin, and vanadium) were detected in all samples, and another 20 elements were detected in part of the samples. Some examples are given in Table 1.

For the majority of elements determined, the results agreed well with previously published data. For some elements in serum, found concentrations were however much lower compared to previous reports. Possibly, earlier data were affected by contamination in pre-analytical steps.

In the same paper (1), element concentrations are given for a human serum reference material (Seronorm Lot MI0181). This material was analyzed both after dilution as described above, and after microwave-assisted acid digestion according to the method used for whole blood. Except for bromine and iodine, there were no differences in the results between the preparation methods. This indicates that simple dilution is adequate for this sample type when using ICP-SFMS.

Serum tubes

Table 1. *Examples of elemental concentrations (ng/ml) in serum from non-exposed subjects (n=12).*

Element	Range	Element	Range
Arsenic	<0.5–3.6	Nickel	0.13–0.55
Cadmium	0.013–0.074	Antimony	0.027–0.063
Chromium	0.05–0.48	Selenium	74–90
Copper	740–1300	Uranium	0.0005–0.01
Mercury	0.21–1.3	Zinc	420–710

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

A later study (2) focussed on 20 low abundant 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. For 16 elements (Y, Zr, Nb, Ag, Sb, Hf, Ta, W, Os, Re, Ir, Pt, Au, Tl, Bi and U), the method was found to be adequate at physiological levels in human serum. 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 found 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 2. *Examples of elemental concentrations (ng/ml) in human serum (3 pools with 30-35 subjects in each).*

Element	Range	Element	Range
Silver	0.11–0.17	Antimony	0.070–0.11
Gold	0.006–0.018	Tantalum	0.008–0.010
Bismuth	0.0016–0.0029	Thallium	0.018–0.021
Platinum	0.0017–0.016	Uranium	0.014–0.015
Rhenium	0.0025–0.0032	Zirconium	0.090–0.16

References

1. 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.

2. 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.