Application Brief 43193

Single Mode Multi-Elemental Analysis of Traditional Chinese Medicine using the Thermo Scientific iCAP Qc ICP-MS

Jianfeng Cui, Julian D. Wills, Shona McSheehy Ducos and Lothar Rottmann,
Thermo Fisher Scientific, Bremen, Germany

Key Words
Traditional Chinese Medicine, ICP-MS, Single Mode KED

Goal
To demonstrate a simple, multi-elemental method for the routine determination of major and trace elements in traditional Chinese medicine using quadrupole ICP-MS.

Introduction
Traditional Chinese Medicine (TCM) is a group of treatments, including herbal medicines, that have been regularly employed over many hundreds of years and are still in use today. Strong tradition and culture have helped to maintain the popularity of TCM and Chinese herbal medicines but in recent years concerns have arisen that they may have been affected by mining and industrial waste. The uptake and storage of heavy metals in plant derived components of TCMs is under scrutiny as excessive exposure is linked to increased risk of metabolic disorders and other potentially degenerative effects[1].

Due to its excellent detection limits, quadrupole ICP-MS has become the standard technique for the determination of trace elements in food and plants – especially the "big four" toxic metals (arsenic, cadmium, lead and mercury). ICP-MS is therefore an important tool to assess the impact of prolonged use of TCM.

In order to demonstrate this, an authentic Ginkgo Leaf sample, a common ingredient in TCM, and two certified reference materials (CRMs) of similar matrix were prepared by microwave digestion and analyzed for their trace metal content by ICP-MS.

Method
All samples were prepared in triplicate with microwave digestion (using 0.5 g of each sample in 5 mL concentrated HNO_3 and 2 mL concentrated H_2O_2). After digestion each sample was made up to 50 mL using ultra pure water and were diluted a further 4-fold directly before analysis. Triplicate method blanks were performed for each microwave digestion batch.

All samples were quantified against an external calibration generated using multi-concentration, multi-elemental standards prepared from certified stock solutions. Final concentrations were method blank subtracted, internal standard corrected and quantified against the calibration curves.

The Thermo Scientific™ iCAP™ Qc ICP-MS was used to perform all analyses. Through its advanced low mass cut off in combination with excellent low mass sensitivity in cell modes, a single He KED measurement mode was used for the analysis of all target analytes.

Reference
1 Translated from the on-line source Chinese Pharmacopoeia Commission at:
http://www.chp.org.cn/cms/business/cm/000127.html

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Table 1: Results for the NIST SRM 1515 Apple Leaves, INCT-OBTL Tobacco Leaves and an example TCM sample (Ginkgo Leaves). All concentrations are reported in mg·kg except where otherwise stated.

	LoD	MDL	NIST SRM 1515 - Apple Leaves		INCT - OBTL Tobacco Leaves		Ginkgo Leaves
	(ng·L^{-1})	(µg·kg^{-1})	Certified	Measured	Certified	Measured	Measured
^{7}Li	4.26	1.70		0.084 ± 0.004		24.4 ± 0.2	0.216 ± 0.019
^{11}B	95.8	38.3	27 ± 2	27.9 ± 0.1	33.6 ± 2.2	36.4 ± 0.6	57.4 ± 4.4
^{23}Na	20.3	8.12	24.4 ± 1.2	25.2 ± 0.6		213 ± 11	118 ± 8
^{24}Mg	8.93	3.57	0.271 ± 0.008 (%)	0.273 ± 0.005 (%)	0.853 ± 0.034 (%)	0.851 ± 0.016 (%)	0.323 ± 0.018 (%)
^{39}K	600	240	1.61 ± 0.02 (%)	1.61 ± 0.018 (%)	2.271 ± 0.076 (%)	2.385 ± 0.069 (%)	0.820 ± 0.053 (%)
^{44}Ca	199	79.6	1.526 ± 0.015 (%)	1.51 ± 0.026 (%)	3.996 ± 0.142 (%)	3.902 ± 0.090 (%)	3.182 ± 0.194 (%)
^{51}V	0.327	0.131	0.26 ± 0.03	0.19 ± 0.04	4.12 ± 0.55	3.89 ± 0.07	0.135 ± 0.009
^{52}Cr	0.845	0.338	(0.3)	0.272 ± 0.004		4.81 ± 0.13	0.291 ± 0.029
^{55}Mn	0.387	0.155	54 ± 3	53 ± 1	180 ± 6	187 ± 2	14 ± 0.7
^{56}Fe	0.377	0.151	83 ± 5	77 ± 2	(0.149 %)	0.149 ± 0.003 (%)	107 ± 5
^{59}Co	0.079	0.032	(0.09)	0.088 ± 0.001	0.981 ± 0.067	0.948 ± 0.016	0.022 ± 0.002
^{60}Ni	0.417	0.167	0.91 ± 0.12	0.88 ± 0.04	8.50 ± 0.49	8.50 ± 0.03	0.224 ± 0.026
^{63}Cu	0.617	0.247	5.64 ± 0.24	5.79 ± 0.15	10.1 ± 0.4	10.1 ± 0.1	4.03 ± 0.19
^{66}Zn	1.52	0.608	12.5 ± 0.3	12.5 ± 0.3	52.4 ± 1.8	53.8 ± 0.4	4.58 ± 0.28
^{75}As	1.17	0.47	0.038 ± 0.007	0.033 ± 0.001	0.668 ± 0.086	0.762 ± 0.055	0.087 ± 0.004
^{78}Se	9.78	3.91	0.050 ± 0.009	0.052 ± 0.001		0.206 ± 0.036	0.067 ± 0.028
^{85}Rb	0.224	0.090	10.2 ± 1.5	9.9 ± 0.3		16.5 ± 0.1	2.97 ± 0.08
^{88}Sr	0.282	0.113	25 ± 2	25 ± 0.5	105 ± 5	102 ± 3	77 ± 2.2
^{95}Mo	0.641	0.256	0.094 ± 0.013	0.092 ± 0.004	0.414 ± 0.062	0.387 ± 0.007	0.336 ± 0.024
^{107}Ag	0.074	0.030		0.004 ± 0.001	0.053 ± 0.0105	0.055 ± 0.001	0.030 ± 0.002
^{111}Cd	0.158	0.063	0.013 ± 0.002	0.013 ± 0.002	2.64 ± 0.14	2.80 ± 0.03	0.012 ± 0.001
^{121}Sb	0.138	0.055	(0.013)	0.012 ± 0.001	0.0755 ± 0.0125	0.070 ± 0.019	0.124 ± 0.003
^{137}Ba	0.407	0.163	49 ± 2	50 ± 1	67.4 ± 3.8	67.9 ± 0.5	42.5 ± 1.3
^{202}Hg	1.04	0.416	0.044 ± 0.004	0.051 ± 0.009	0.0209 ± 0.0013	0.0258 ± 0.0052	0.059 ± 0.006
^{205}Tl	0.024	0.009		0.012 ± 0.001	(0.0513)	0.051 ± 0.002	0.010 ± 0.001
^{208}Pb	0.035	0.014	0.470 ± 0.024	0.435 ± 0.056	2.01 ± 0.31	1.90 ± 0.03	0.899 ± 0.057
^{238}U	0.051	0.020	(0.006)	0.006 ± 0.001		0.077 ± 0.005	0.003 ± 0.001

Results

Figure 1 shows typical external calibration curves for Co and As in KED mode.

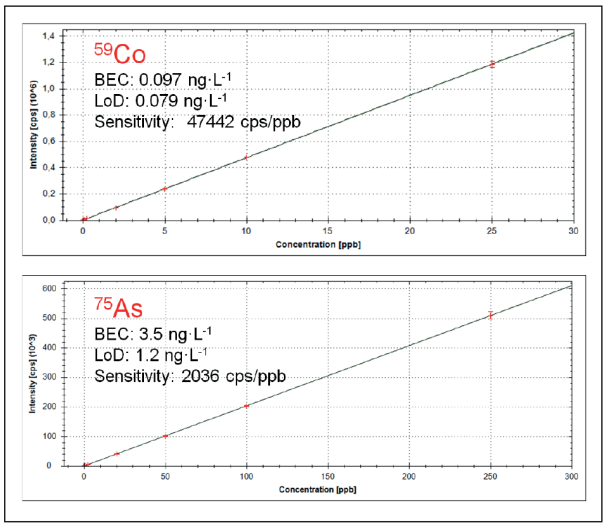

Figure 1: Fully quantitative five point calibration curves.

The results for the Apple and Tobacco Leaf CRMs and a genuine TCM (Gingko Leaves) are presented in Table 1. The concentrations determined for all trace metals in the two CRMs analyzed are with the certified ranges. The elemental profile of the Gingko Leaf sample analyzed is similar to that of the Apple Leaf CRM.

Conclusion

The iCAP Qc ICP-MS has been shown to be an excellent tool for the accurate, multi-elemental analysis of trace metals in complex samples, offering:

- A wide dynamic range (measuring µg·kg^{-1} to % levels in a single analysis).
- High instrument sensitivity.
- Freedom from interferences using a single He KED analysis mode.
- An easy-to-use workflow enabled by the Thermo Scientific™ Qtegra™ Intelligent Scientific Data Solution (ISDS).

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