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Application News

No.J121

Inductively Coupled Plasma Mass Spectrometry

Analysis of Plant Materials Using the ICPMS-2030

Introduction

Foods contain many different types of elements with a variety of concentrations. It is important to assess the concentrations of elements in order to know the intake of nutrients and manage the health risks from toxic elements.
A variety of analytical instruments are used for elemental analysis. Among these, ICP mass spectrometers are ideal for the analysis of foods because they can analyze many elements at a time with high sensitivity.

In this study, we performed a simultaneous analysis of plant materials using the Shimadzu ICPMS-2030 ICP mass spectrometer. The ICPMS-2030 contains a database of all the elements, so it can assess concentrations even for elements with no standard sample. Therefore, we also conducted qualitative analysis.

Sample

Tea leaves

Sample Preparation

We used the microwave digestion method that could decompose samples faster than the typically used wet digestion method. Since this method uses a closed vessel, it also has the advantage that loss of volatile elements such as arsenic is minimal. In this study, the sample was decomposed using the Milestone General ETHOS-One.

0.2 g of the sample, 0.5 mL of hydrochloric acid, and 6.5 mL of nitric acid were added to a quartz vessel of the microwave digestion system for sample preparation. The mixture was then decomposed by the microwave digestion system.
After sample decomposition, pure water was added to bring the measurement solution to a volume of 100 mL. At this point, Ga, In, Co, Sc, and Bi (at a 10 µg/L concentration in measurement solution) were added as the internal standard elements.
The sample decomposition conditions are shown in Table 1.

Table 1 Sample Decomposition Conditions Using the Microwave Digestion System for Sample Preparation

Step	Temperature (°C)	Time (min)	Power (W)
1	50	2	1000
2	30	3	0
3	180	25	1000
4	150	1	0
5	180	4	1000
6	180	15	1000

Analysis

A simultaneous quantitative measurement of the mineral components and toxic components in tea leaves was performed using the calibration curve method.
To verify the analysis results, a spike and recovery test sample was created by adding a standard solution of measurement elements after the sample decomposition. Quantitative analysis was performed in the same way using this sample.

Analytical Results

Table 2 shows the quantitative results. Favorable spike recovery rates were also obtained in the spike and recovery test.
The qualitative results were calculated after the measurement. Table 3 shows the qualitative results (semi quantitative values), and Fig. 1 shows the total mass profile.The qualitative results were calculated using the database included in the software. Thus, it was possible to assess the composition even for elements without a calibration curve sample.

Conclusion

Using the ICPMS-2030 enables simultaneous analysis of everything from the mineral components to trace toxic components in plant materials.
The ICPMS-2030 can also calculate qualitative values based on the profile measurement data, even for components that are not qualitatively analyzed. Therefore, just from a postrun analysis, it is possible to obtain information on elements that are not actually quantitated.

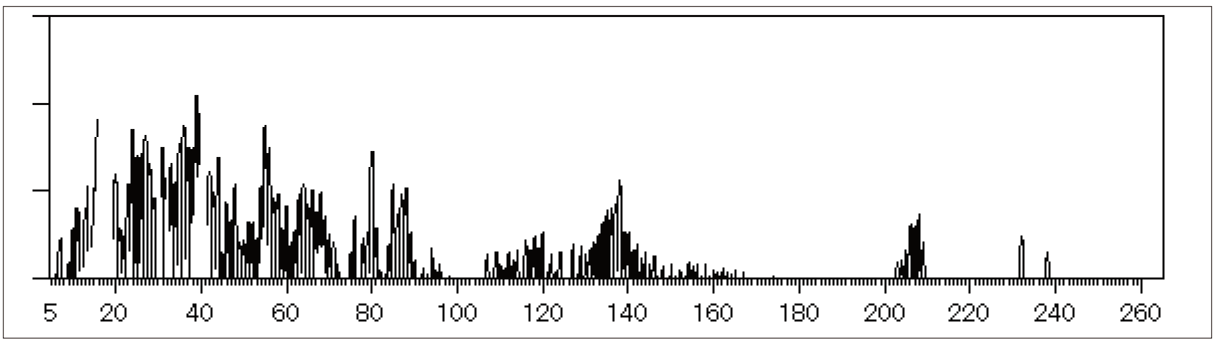

Fig. 1 Total Mass Profile

Table 2 Quantitative Results
(concentrations in solid sample)

	Quantitative Results	Spike Recovery Rate
Unit	µg/g	%
P	3300	95
Ca	2900	97
Mg	1370	97
Al	660	93
Mn	590	92
Fe	85	98
Zn	32	102
Cu	6.0	98
Ni	5.7	98
As	0.010	95
Cd	0.028	100
Cr	0.13	102
Pb	0.33	100

Spike recovery rate (%) = { (Analysis value for the spike recovery test sample – Analysis value) / Spike concentration} × 100

Table 3 Qualitative Results
(concentration in measurement solution, µg/L)

Cl	280000	Bi	(0.11)
K	17200	Nd	(0.088)
Ca	5400	Cs	(0.080)
S	5200	Te	< 0.060
P	3200	U	(0.054)
Mg	1200	Tl	(0.049)
Mn	820	Ag	(0.042)
Al	530	Hg	< 0.038
Si	170	Sc	(0.025)
Fe	130	Pr	(0.024)
Zn	27	Zr	(0.023)
Na	20	Gd	(0.020)
B	17	Mo	(0.019)
Ba	13	Pt	< 0.015
Cu	8.3	Sb	(0.014)
Rb	7.5	Dy	(0.013)
Ni	6.6	Pd	< 0.012
Sr	4.7	Sm	(0.012)
Pb	1.3	Ge	< 0.011
Br	(4.0)	Ru	< 0.0088
Ti	(3.2)	Au	< 0.0084
Se	< 2.6	W	< 0.0083
Pb	1.3	Yb	(0.0067)
Li	(0.78)	Ir	< 0.0065
Sn	(0.63)	Er	(0.0059)
V	(0.46)	Hf	< 0.0051
Cr	(0.30)	In	< 0.0051
Co	(0.29)	Os	< 0.0049
Be	(0.23)	Eu	< 0.0044
Th	(0.19)	Nb	(0.0042)
Ce	(0.16)	Ho	(0.0037)
I	(0.16)	Re	< 0.0031
As	< 0.15	Tb	(0.0028)
La	(0.15)	Rh	< 0.0022
Cd	(0.13)	Ta	< 0.0022
Ga	(0.12)	Lu	< 0.0019
Y	(0.12)	Tm	< 0.0016

First Edition: Aug. 2016

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