

Determination of Rare Earth Elements in Tea by ICP-AES with Ultrasonic Aerosol Generator

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Introduction

In this paper, a method for determination of rare earth elements using ICP-AES with UAG-1 is established. UAG-1(Ultrasonic aerosol Generator) is an accessory for ICP-AES, which can increase the sensitivity of ICP-AES for more than 3 times. With this method, tea leaves samples were digested with HNO_3 - HClO_4 mixed system by wet digestion. And standard addition method was applied. Under the optimum conditions, the limit of detection of

rare earth elements in tea leaves base less than 0.005 mg/L. The recoveries for rare earth elements determination range from 90% to 105.0%. The accuracy of this method was evaluated by measured the tea standard reference material, and the results matched the certified values well. With high accuracy and good precision, this method is suitable for trace determination of rare earth elements in tea leaves.

Materials and Methods

Standard reference material (GBW10016) were purchased from National Institute of Metrology. The system is shown in Fig. 1.



Fig. 1 ICPE-9000

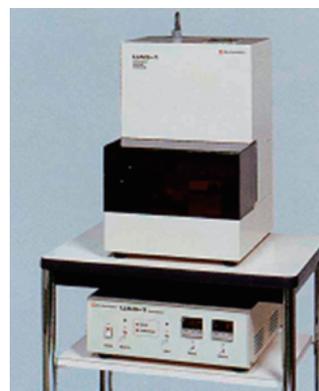


Fig. 2 UAG-1

Sample pretreatment

A standard reference material (GBW10016), green tea sample and a Pu'er tea sample were measured. 1.0 g samples were weighed accurately, and transferred into 100 mL backers, and 10 mL HNO_3 and 2.0 mL HClO_4 were added, and then

heated on a hot plate at 190 °C for digestion. The samples were evaporated to nearly dry. After cooling, sample solutions were transferred to 25 mL flasks with 5% HNO_3 , and then set up to the scale using 5% HNO_3 .

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Analytical conditions

Table 1 Analytical Conditions

Instrument	ICPE-9000 with UAG-1	Sample Introduction	Ultrasonic Aerosol Generator
Radio Frequency Power	1.0 kW	Misting Chamber	Cyclone Chamber
Plasma Gas	14 L/min	Plasma Torch	Standard Torch
Auxiliary Gas	1.2 L/min	View Direction	Axial
Carrier Gas	0.6 L/min	-	-

Results

Optimum wavelengths and Detection Limit

Table 2 wavelengths and Detection Limit

Elements	Wavelength (nm)	Detection Limit (mg/L)	Element	Wavelength (nm)	Detection Limit (mg/L)
Ce	413.380	0.0022	Nd	406.109	0.0035
Dy	387.212	0.0028	Pr	440.884	0.0043
Er	349.910	0.0018	Sm	460.949	0.0016
Eu	381.967	0.00034	Tb	350.917	0.0011
Gd	342.247	0.0019	Tm	346.220	0.00079
Ho	345.600	0.00040	Y	360.073	0.00053
La	408.672	0.0014	Yb	328.937	0.00011
Lu	350.739	0.00091	-	-	-

Measurement results

The measuring results of the standard material GBW10016 (tea leaves) are showed in Table3, quantitation results of Pu'er tea and green tea samples are shows in Table4. And

the spike test results using green tea sample are showed in Table5.

Table 3 Quantitation Results of GBW10016

Element	GBW10016 Certified Value	GBW10016 Quantitation Results	Unit	RSD (%)
Ce	0.39±0.05	0.39	µg/g	6.51
La	0.25±0.02	0.248	µg/g	1.95
Nd	0.15±0.02	0.15	µg/g	6.41
Y	0.23±0.03	0.208	µg/g	0.52
Yb	0.018±0.004	0.02	µg/g	2.88

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Table 4 Quantitation Results of tea leaves samples

Element	Pr'er tea (µg/g)	RSD (%)	Green tea (µg/g)	RSD (%)	Element	Pr'er tea (µg/g)	RSD (%)	Green tea (µg/g)	RSD (%)
Ce	1.865	2.66	N.D	-	Nd	0.973	1.41	N.D	-
Dy	N.D	-	N.D	-	Pr	N.D	-	N.D	-
Er	0.1475	3.03	N.D	-	Sm	N.D	-	N.D	-
Eu	0.035	3.24	N.D	-	Tb	N.D	-	N.D	-
Gd	N.D	-	N.D	-	Tm	N.D	-	N.D	-
Ho	N.D	-	N.D	-	Y	1.45	0.51	0.04	3.33
La	1.24	1.39	N.D	-	Yb	0.173	0.90	N.D	-
Lu	N.D	-	N.D	-	-	-	-	-	-

Table 5 Spike and recovery results

Element	Before Spiked (mg/L)	Added amount (mg/L)	After Spiked (mg/L)	Recovery (%)	Element	Before Spiked (mg/L)	Added amount (mg/L)	After Spiked (mg/L)	Recovery (%)
Ce	0.0032	0.02	0.0219	93.5	Nd	0.0024	0.02	0.0212	94.0
Dy	-0.0004		0.0181	92.5	Pr	-0.003		0.0182	106.0
Er	-0.0006		0.0183	94.5	Sm	-0.0004		0.0185	94.5
Eu	-0.0001		0.0182	91.5	Tb	-0.0003		0.0184	93.5
Gd	0.0011		0.0194	91.5	Tm	0.0003		0.0185	91.0
Ho	-0.0002		0.0182	92.0	Y	0.0016		0.0198	91.0
La	0.0015		0.0207	96.0	Yb	0.0001		0.0182	90.5
Lu	-0.0007		0.018	93.5	-	-		-	-

Conclusion

Rare earth elements in tea leaves samples including standard sample (GBW10016) were determined by ICP-OES and Ultrasonic Aerosol Generator system. Based on the qualitative results of samples with the ICPSolution software, the tea leaves contained large amount of salt normally, such as phosphate and sulfate and so on. The complex matrix of samples can produce negative influence to measuring. Therefore, standard addition method was used instead of calibration curve method, in order to

eliminate matrix interference. The results show that the quantitation results of rare earth elements in GBW10016 matched the certified values well. And the recovery results for rare earth elements ranges from 90.5%~106.0%. The detection limits of rare earth elements in tea leaves base less than 5 ng/mL, which are superior to ICP-AES. This method is suitable for trace-determination of rare earth elements in tea leaves.