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Application News

No.J103

Inductively Coupled Plasma Atomic Emission Spectrometry

# Simultaneous Analysis of Trace and Major Elements in Rice by ICPE-9820

## Introduction

Among the world's three major crops, rice, corn, and wheat, rice is the staple food crop of the people of Asia. Brown rice refers to the grain that remains after the outer shell is removed from the rice fruit. Also, once the germ and rice bran are removed by milling the surface of the brown rice, the remaining grain is referred to as white rice. As brown rice contains a good balance of nutrients, including proteins and lipids, minerals, vitamins, and dietary fiber, this grain is gaining widespread recognition as a health food in recent years. Aside from the benefits of nourishment however, health problems associated with rice have occurred due to contamination from polluted water and other farmland contaminants. In particular, cadmium (Cd) consumed over a long period of time can result in kidney failure, and is therefore strictly regulated so as to contain less than 0.4 mg/kg by international standards (CODEX).
Brown rice contains potassium (K) and phosphorus (P) as major elements, at about %. However, to conduct simultaneous analysis of its principle beneficial elements together with toxic trace elements such as cadmium (Cd), an instrument having a wide dynamic range is required.
Here, using the Shimadzu ICPE-9820 multi-type ICP atomic emission spectrometer, we conducted simultaneous analysis of the elements present in brown rice samples. The ICPE-9820, with its dual plasma axial (AX) / radial axis (RD) viewing, permits the simultaneous analysis of elements present at high- to trace-level concentrations.

## Sample

Brown rice powder standard samples NIES No. 10-a, -b, and -c

## Sample Preparation

After weighing out 0.4 g of sample into a digestion vessel, 4.5 mL nitric acid and 0.5 mL hydrochloric acid were added, and the sample was set aside for about one hour for pre-reaction processing. The decomposition vessel was then sealed, and digestion was conducted using a microwave sample preparation system. After cooling, the digest solution volume was adjusted to 20 mL using distilled water, and this was used as the sample solution.

## Instrument and Analytical Conditions

The ICPE-9820 was used for the analysis. The analytical conditions are shown in Table 1. The ICPE-9820 features auto-switching between radial view (RD) measurement for high-concentration elements and the axial view (AX) for high sensitivity measurement. Fig. 1 shows calibration curves for K (maximum concentration 200 mg/L) using the axial view and radial view, respectively. Better linearity was obtained with the radial view than with the axial view for K at a high -concentration. On the other hand, for Cd at a trace level concentration, high sensitivity measurement can be conducted using the axial view. Thus, by conducting measurement utilizing automatic switching of the two views, high-concentration components and trace components can be measured simultaneously using the same solution.

**Table 1 Analytical Conditions**

| | |
|---|---|
| Instrument | : ICPE-9820 |
| Radio frequency power | : 1.2 kW |
| Plasma gas Flowrate | : 10 L/min |
| Auxiliary gas Flowrate | : 0.6 L/min |
| Carrier gas Flowrate | : 0.7 L/min |
| Sample introduction | : Nebulizer 10 |
| Misting chamber | : Cyclone chamber |
| Plasma torch | : Mini Torch |
| Observation | : Axial (AX) / Radial (RD) |

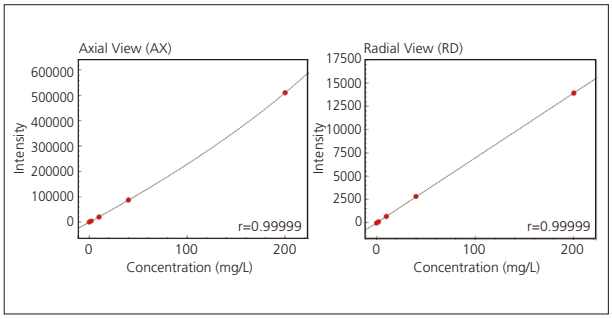


**Fig. 1 Calibration Curves of K766.490 nm by Axial View and Radial View (Maximum Concentration 200 mg/L)**

## Analysis

Quantitative analysis was conducted by the calibration curve method.

[Reference]
1) CODEX GENERAL STANDARD FOR CONTAMINANTS AND TOXINS IN FOODS (CODEX STAN 193-1995, Rev. 3-2007)

## Analytical Results

Table 2 shows the analytical results. Fig. 2 and 3 show the spectral profile and calibration curve, respectively, for Cd.
Analysis of the brown rice standard substances conducted here indicated 3 levels of Cd contamination. However, all were present at trace levels, below the regulatory limit of 0.4 mg/kg, indicating good results. Further, excellent results were also obtained for many of the elements other than Cd, with values closely matching the certified values.

## Conclusion

Using the ICPE-9820, Cd can be analyzed at trace levels with high sensitivity, while high-concentration principle component elements (K, P, etc.) present in the same solution can be analyzed at the same time.

**Table 2 Analytical Results for Brown Rice (Unit: µg/g)**

| Element | NIES No.10-a | | NIES No.10-b | | NIES No.10-c | |
|---|---|---|---|---|---|---|
| | Quantitation Value | Certified Value | Quantitation Value | Certified Value | Quantitation Value | Certified Value |
| Al | 3.1 | (3) | 2.1 | (2) | 1.7 | (1.5) |
| Ca | 96 | 93 ± 3 | 79 | 78 ± 3 | 96 | 95 ± 2 |
| Cd | 0.02 | 0.023 ± 0.003 | 0.31 | 0.32 ± 0.02 | 1.80 | 1.82 ± 0.06 |
| Cu | 3.6 | 3.5 ± 0.3 | 3.4 | 3.3 ± 0.2 | 4.3 | 4.1 ± 0.3 |
| Cr | 0.08 | (0.07) | 0.20 | (0.22) | 0.10 | (0.08) |
| Fe | 12.2 | 12.7 ± 0.7 | 12.8 | 13.4 ± 0.9 | 10.9 | 11.4 ± 0.8 |
| K | 2750 | 2800 ± 80 | 2520 | 2450 ± 100 | 2780 | 2750 ± 100 |
| Mn | 33.8 | 34.7 ± 1.8 | 30.8 | 31.5 ± 1.6 | 39.4 | 40.1 ± 2.0 |
| Mo | 0.37 | 0.35 ± 0.05 | 0.45 | 0.42 ± 0.05 | 1.63 | 1.6 ± 0.1 |
| P | 3430 | 3400 ± 70 | 3180 | 3150 ± 60 | 3380 | 3350 ± 80 |
| Pb | 1.1 | - | 1.2 | - | 1.2 | - |
| Zn | 24.8 | 25.2 ± 0.8 | 22.0 | 22.3 ± 0.9 | 22.8 | 23.1 ± 0.8 |

Values in parentheses are reference values.

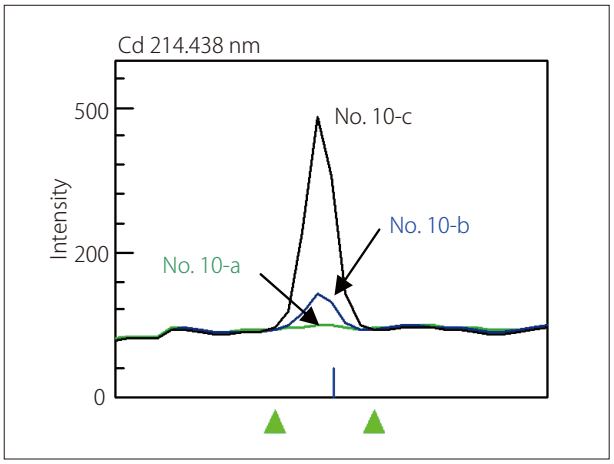


**Fig. 2 Spectral Profile of Cd**

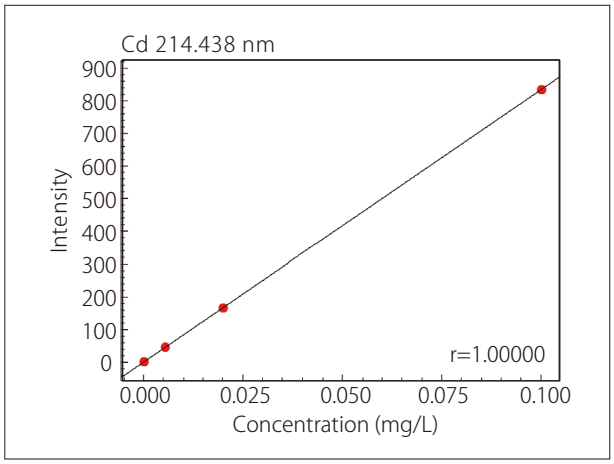


**Fig. 3 Calibration Curve of Cd**

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