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Application News

Shimadzu Energy Dispersive X-Ray Fluorescence Spectrometer EDX-8100

Analysis of Minerals and Screening Analysis for Hazardous Elements in Food by EDXRF

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User Benefits

- EDXRF can analyze minerals in foods as-is or with only simple sample preparation.
- Nondestructive analysis of samples in various forms, including solid, liquid, and powder, is possible.
- Light elements can be analyzed with higher sensitivity by analysis under a vacuum or helium replacement atmosphere.

■ Introduction

Reduction of food loss is an international challenge, as also taken up in the Sustainable Development Goals (SDGs) established by the United Nations. Various initiatives are being carried out toward the solution of this problem, including moves to evaluate the nutritional value of food waste that had been discarded until now, with the aim of recycling. For example, the core of cabbage was usually treated as an object of waste disposal and had been diverted to other uses such livestock feed or compost, but because it is rich in minerals, use in health foods and processed foods is expected.

The atomic absorption spectrophotometer (AA) and inductively coupled plasma mass spectrometer (ICP-MS) are widely used in component analysis of foods. While these analytical methods are superior in terms of sensitivity, they also have the problem that a high level of technology and skill is required in the analysis because chemical sample preparation is necessary, for example by dissolving specimens with an acid such as nitric acid or hydrochloric acid.

On the other hand, the energy dispersive X-ray fluorescence spectrometer (EDXRF) has the feature that analyses can be carried out with the sample as-is or with only simple sample preparation. This Application News introduces the following, focusing on measures to reduce food loss and safety evaluation of foods.

1. Evaluation of minerals in cabbage
2. Screening analysis of hazardous elements

1. Evaluation of Minerals in Cabbage

■ Sample

Cabbage

■ Sample Preparation

The cabbage core and leaves were pulverized with a mixer and dried at 85 ˚C for 6 hours. The samples were then packed in vinyl chloride rings with an inner diameter of 22 mmφ and compacted at 40 kN for 10 seconds. Fig. 1 shows an outline of the sample preparation procedure.

■ Results of Qualitative and Quantitative Analysis

Fig. 2 shows the profile overlays of the cabbage core and leaf parts, and Table 1 shows the results of an FP (fundamental parameter) quantitative analysis. The main component was set as cellulose ($C_6H_{10}O_5$), a fiber. From these results, there is no difference in the elements detected in the cabbage core and leaves, but the core contains larger amounts of minerals such as phosphorus (P) and potassium (K).

Fig. 1 Outline of Sample Preparation Procedure

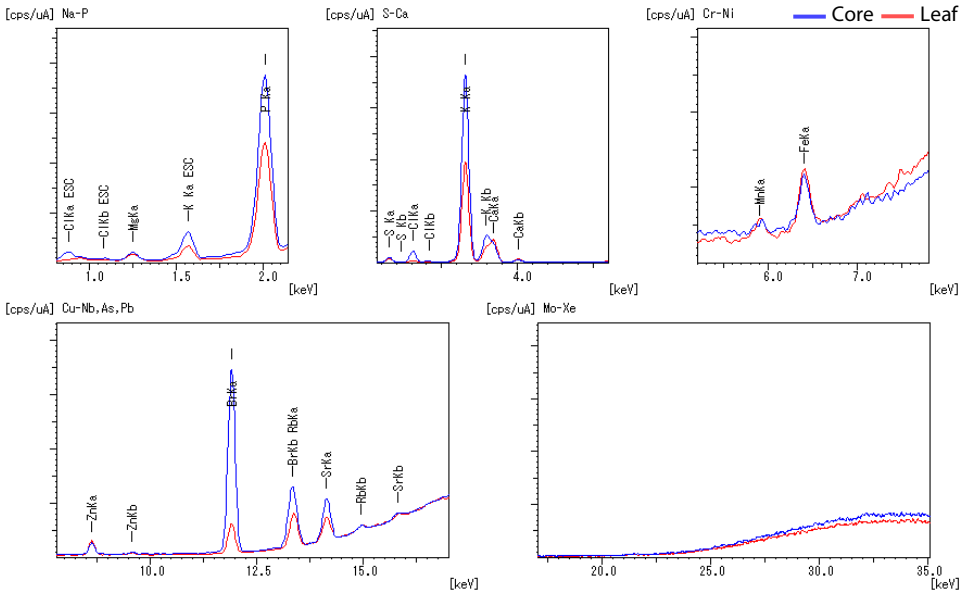

Fig. 2 Profile Overlays of Core and Leaf of Cabbage

Table 1 Results of FP Quantitative Analysis*1

Element	Core [mass%]	Leaf [mass%]	Element	Core [ppm]	Leaf [ppm]
Mg	0.14	0.13	Mn	6.20	11.4
P	0.50	0.32	Fe	27.1	23.2
S	0.93	0.78	Zn	31.4	27.5
Cl	1.14	0.18	Br	159.9	17.1
K	6.32	2.82	Rb	23.0	13.2
Ca	0.51	0.44	Sr	23.2	8.70

*1 Quantitation calculation was performed assuming $C_6H_{10}O_5$ balance.

2. Screening Analysis of Hazardous Elements

■ Sample

CRM 7403-a No. 52 Swordfish meat powder standard sample

■ Sample Preparation

The sample was packed in a vinyl chloride ring with an inner diameter of 22 mmφ and pressed at 40 kN for 10 seconds. Fig. 3 shows the appearance of the sample.

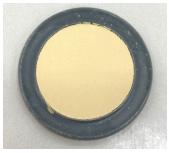

Fig. 3 Appearance of Sample

■ Results of Qualitative and Quantitative Analysis

Table 2 shows a summary of the standard values and the quantitative analysis values of the swordfish meat powder standard sample. The main component was set as CH_2O, representing organic substances as a whole. EDXRF can quantify the hazardous elements As and Hg which are present in trace amounts with high accuracy, even without standard samples.

■ Conclusion

Simple component analysis of foods is possible with EDXRF. This analysis method has low environmental loads because chemical sample preparation is not necessary. Even trace elements can be analyzed at the ppm order, and highly accurate quantitative analysis is possible even without using standard samples.

Shimadzu EDXRF supports initiatives to achieve the SDGs in the analysis aspect.

■ Analysis Conditions

Table 3 Analysis Conditions

Instrument	: EDX-8100
Elements	: $_{6}C$ - $_{92}U$
Analysis group	: Qualitative/quantitative analysis
Detector	: SDD
X-ray tube	: Rh target
Tube voltage	: 15 [kV] (Na-P), (S-Ca) 50 [kV] (Cr-Ni), (Cu-Nb, As, Pb), (Mo-Xe)
Tube current	: Auto [μA]
Collimator	: 10 [mmφ]
Primary filters	: None (Na-P), #2 (S-Ca), #3 (Cr-Ni), #4 (Cu-Nb, As, Pb), #1 (Mo-Xe)
Atmosphere	: Vacuum
Integration time	: 120 [s] (Na-P) 60 [s] × 4 (S-Ca), (Cr-Ni), (Cu-Nb, As, Pb), (Mo-Xe)
Dead time	: Max 30 [%]

Table 2 Result of Standard Values and FP Quantitative Analysis Values*2

Element	Standard value [mass%]	Quantitation value [mass%]	Element	Standard value [ppm]	Quantitation value [ppm]
Na	0.36	0.41	Fe	13.1	15.3
Mg	0.16	0.17	Zn	33.6	40.0
P	1.45	1.61	As	6.62	6.1
S	-	1.13	Se	2.14	1.7
Cl	-	0.62	Br	-	22.1
K	2.63	3.12	Rb	-	2.3
Ca	0.02	0.03	Sr	1.13	1.0
			Hg	5.34	5.5

*2 Quantitation calculation was performed assuming CH_2O balance.

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