EDXRF Analysis of Arsenic in Foods

X-ray fluorescence spectrometers enable quickly, easily, and non-destructively analyzing solids, powders, liquids, and other samples. In particular, they are useful for detecting and quantitatively analyzing arsenic (As), cadmium (Cd), and potassium (K), and other elements in toxic substances in foods. The following is an example of analyzing arsenic levels of sodium arsenite mixed in oolong tea, juice, and curry. EDX-700/800 models include five types of primary filters as standard accessories, which are required for trace analysis of substances such as arsenic. An example of trace analysis is also described below.

**Samples**
Samples were prepared by mixing sodium arsenite (NaAsO₂) with commercially marketed oolong tea, juice, and curry (in retort packaging) to an arsenic concentration of about 0.4%.

**Sample Preparation**
About 6 mL of untreated samples were placed in liquid containers with 6 μm thick PET film adhered to the bottom.

**Analysis Results**
Qualitative analysis results for oolong tea, juice, and curry are shown in Fig. 1, 2, and 3. Quantitative analysis values are indicated in Table 1. Equations were balanced assuming H₂O (water) as the primary ingredient and ignoring all non-arsenic elements.

<table>
<thead>
<tr>
<th>Element</th>
<th>Oolong Tea</th>
<th>Juice</th>
<th>Curry</th>
</tr>
</thead>
<tbody>
<tr>
<td>As</td>
<td>0.39 %</td>
<td>0.35 %</td>
<td>0.33 %</td>
</tr>
<tr>
<td>H₂O</td>
<td>99.61 %</td>
<td>99.65 %</td>
<td>99.67 %</td>
</tr>
</tbody>
</table>

**Table 1 Quantitative Value of As in Foods**

![Fig. 1 Qualitative and Quantitative Analysis of Oolong Tea](image1)

![Fig. 2 Qualitative and Quantitative Analysis of Juice](image2)
EDXRF Analysis of Trace Arsenic Using Primary Filter

Trace analysis requires using a primary filter. Using a primary filter enables reducing the scattering of primary X-rays from the X-ray tube to obtain measurements with good S/N ratios. Consequently, heavy metals such as arsenic can be detected down to a few ppm. The following is an example of analyzing trace arsenic in an aqueous solution using a nickel primary filter. The nickel filter is also required for trace analysis of Cu, Zn, Mo, Ta, W ... and U as well.

Samples

A 10 ppm aqueous solution was used, containing a standard 1000 ppm solution of arsenic for atomic absorption spectrometry, diluted by 100 times.

Analysis Results

Qualitative analysis results from the 10 ppm aqueous arsenic solution with and without using a nickel filter are shown overlaid in Fig. 4. Based on these results, detection limits were calculated for with and without using a nickel filter, as shown in Table 2.

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Result</th>
<th>Std. Dev.</th>
<th>Calculation</th>
<th>Line</th>
<th>Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS</td>
<td>0.329 %</td>
<td>0.002</td>
<td>Quant.-FP</td>
<td>AsKa</td>
<td>64.851</td>
</tr>
<tr>
<td>H2O</td>
<td>99.671 %</td>
<td>-</td>
<td>Balance</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

![Fig. 3 Qualitative and Quantitative Analysis of Curry](image)

![Fig. 4 Qualitative Analysis With and Without Ni Filter](image)

Table 2 Detection Limits* of As in Aqueous Solution

<table>
<thead>
<tr>
<th></th>
<th>With Ni Filter</th>
<th>Without Ni Filter</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9 ppm</td>
<td>2.0 ppm</td>
<td></td>
</tr>
</tbody>
</table>

*Detection limits calculated as follows:

\[ \text{L.L.D.} = 3 \frac{C}{I_{\text{net}}} \sqrt{\frac{I_{\text{net}}}{T} + \frac{I_{\text{back}}}{T}} \]

- $C$: Standard value
- $I_{\text{net}}$: Net intensity
- $I_{\text{back}}$: Background intensity
- $T$: Measurement time

Analytical Conditions

- **Instrument**: EDX-700
- **X-Ray Tube**: Rh target
- **Filter**: Ni or without
- **Voltage – Current**: 50 kV – 15 μA (auto)
- **Atmosphere**: Air
- **Measurement Diameter**: 10 mm
- **Measurement Time**: 40 sec
- **Dead Time**: 25 %