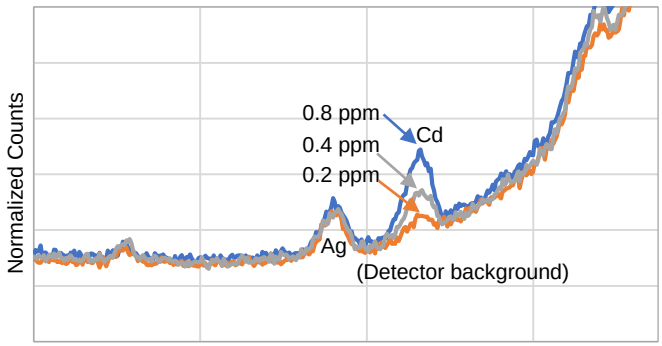
# E-max™

# Rapid Cadmium Testing in Food

## Quantification of Unprecedented Low-level Cd By Monochromatic Excitation XRF

E-max is a monochromatic energy-dispersive x-ray fluorescence analyzer using a monochromatic beam optimized for Cd excitation. It delivers unprecedented Cd LOD taking advantage of the superior signal/background (S/B) ratio. It can rapidly survey and quantify low-level Cd in food with no or minimal sample preparation. Figure 1 shows Cd K-α signal peaks from three different rice samples.

**Figure 1. Cd Signals for Different Rice Samples**




## FP Approach Calibration

E-max applies fundamental-parameters (FP) approach to calibrate the system, using reference material to refine FP parameters. The FP approach allows E-max to measure various types of food with one calibration curve. Custom calibration curves can also be established to further improve accuracy for some specific sample types. Figure 2 shows Cd in dried rice, tomato and spinach.

**Figure 2. Cd in Rice and Dried Vegetables**

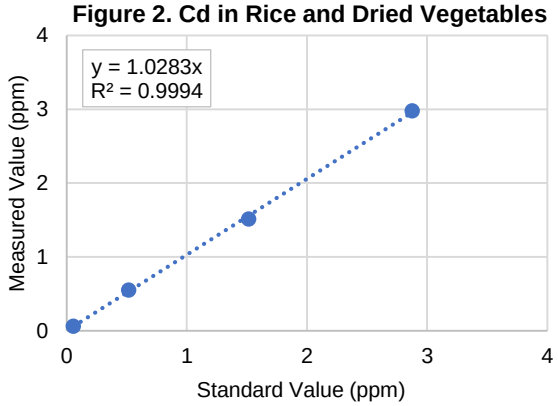
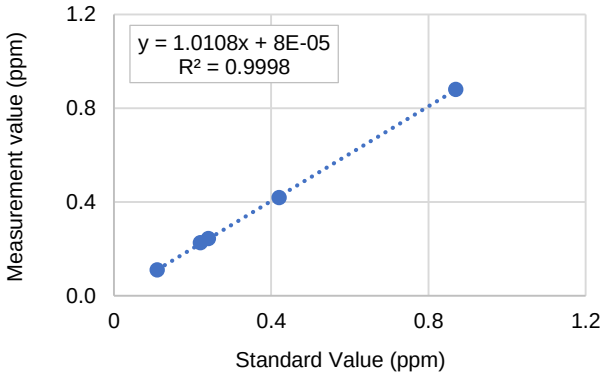



**Figure 3. Cd in Rice**




## Grain Application

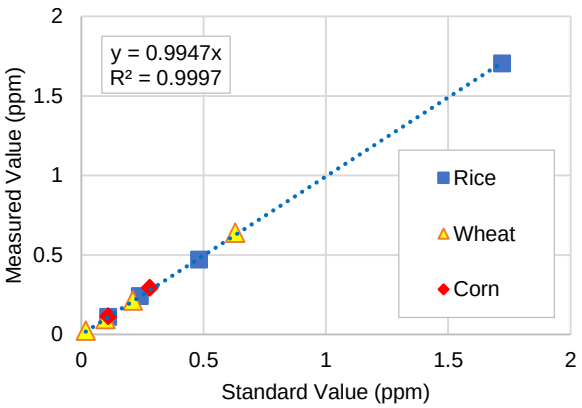
A custom calibration curve for rice, as shown in Figure 3, is obtained using a set of reference rice standards. Various rice, wheat, and corn standard samples are validated based on this curve. The validation results are shown in Table 1 and Figure 4.

**Table 1. Cd in Grain (Unit: ppm)**

| Sample | GBW10046 Wheat | GBW100496 Wheat | GBW08503C Wheat | GBW100493 Wheat | GBW100361 Rice | GBW100348 Rice | R080684a Rice | GBW100356 Rice | GBW100498 Corn | GBW100497 Corn |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 0.021 | 0.086 | 0.214 | 0.635 | 0.103 | 0.255 | 0.478 | 1.682 | 0.137 | 0.307 |
| **2** | ND | 0.105 | 0.204 | 0.648 | 0.097 | 0.237 | 0.452 | 1.741 | 0.108 | 0.296 |
| **3** | 0.027 | 0.098 | 0.223 | 0.638 | 0.132 | 0.232 | 0.482 | 1.691 | 0.102 | 0.280 |
| **Average** | 0.024 | 0.096 | 0.214 | 0.640 | 0.111 | 0.241 | 0.471 | 1.705 | 0.116 | 0.294 |
| **RSV** | 0.018 | 0.100 | 0.211 | 0.630 | 0.110 | 0.240 | 0.482 | 1.720 | 0.110 | 0.280 |
| **Accuracy** | 33.4% | 3.6% | 1.3% | 1.6% | 0.7% | 0.6% | 2.4% | 0.9% | 5.3% | 5.1% |

Figure 4 shows the validation results of rice, wheat, and corn standard samples .

**Figure 4. Cd in Grain**




## Real Sample Testing

Cd in selected food samples in US markets has been tested with minimum sample preparation, as shown in Table 2.

**Table 2. Cd in selected food samples (Unit: ppm)**

| Sample | Cereal | Chocolate | Dark Chocolate | Orzo Pasta | Salted Seaweed |
|---|---|---|---|---|---|
| | | | | | |
| **1** | ND | 0.085 | 0.137 | 0.098 | 0.319 |
| **2** | ND | 0.077 | 0.131 | 0.099 | 0.328 |
| **3** | 0.019 | 0.089 | 0.143 | 0.109 | 0.331 |
| **Average** | 0.019 | 0.084 | 0.137 | 0.102 | 0.326 |

## Repeatability and Accuracy

With the fundamental-parameter approach, E-max can be calibrated for various types of grain with high accuracy and excellent repeatability, as indicated in Table 3. The LOD of Cd is estimated to be 30ppb for 600s testing time.

**Table 3. Repeated Measurements of Reference Standards and Others (Unit: ppm)**

| Sample | NMIJ7501 | NMIJ7502 | NIST1573 | NIST1570 | Pasta | Dark Chocolate |
|---|---|---|---|---|---|---|
| **Testing time (s)** | 900 | 300 | 100 | 100 | 600 | 600 |
| **1** | 0.069 | 0.572 | 1.430 | 3.013 | 0.099 | 0.137 |
| **2** | 0.056 | 0.593 | 1.605 | 2.959 | 0.096 | 0.131 |
| **3** | 0.054 | 0.551 | 1.462 | 2.874 | 0.099 | 0.143 |
| **4** | 0.056 | 0.570 | 1.473 | 2.911 | 0.107 | 0.140 |
| **5** | 0.062 | 0.559 | 1.607 | 3.044 | 0.134 | 0.135 |
| **6** | 0.050 | 0.546 | 1.553 | 2.966 | 0.109 | 0.146 |
| **7** | 0.055 | 0.561 | 1.460 | 3.093 | 0.107 | 0.153 |
| **8** | 0.054 | 0.541 | 1.472 | 3.031 | 0.106 | 0.159 |
| **9** | 0.063 | 0.560 | 1.553 | 2.984 | 0.105 | 0.155 |
| **10** | 0.074 | 0.570 | 1.534 | 3.027 | 0.120 | 0.152 |
| **Average** | 0.059 | 0.562 | 1.515 | 2.990 | 0.108 | 0.145 |
| **RSV** | 0.052 | 0.548 | 1.517 | 2.876 | NA | NA |
| **SD** | 0.007 | 0.014 | 0.060 | 0.062 | 0.011 | 0.009 |
| **RSD** | 12.2% | 2.5% | 4.0% | 2.1% | 9.8% | 6.1% |
| **Accuracy** | 12.7% | 2.5% | 0.1% | 3.8% | NA | NA |

**RSV**: Reference Standard Value
**SD**: Standard Deviation
**RSD**: Relative Standard Deviation