

# E-max



## Rapid Measurement of Cadmium in Chocolate Production



Cocoa bean



Cocoa powder



Cocoa liquor

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

E-max is a portable 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- $\alpha$  signal peaks from three different cocoa powder samples.

Figure 1. Cd peaks in cocoa powder

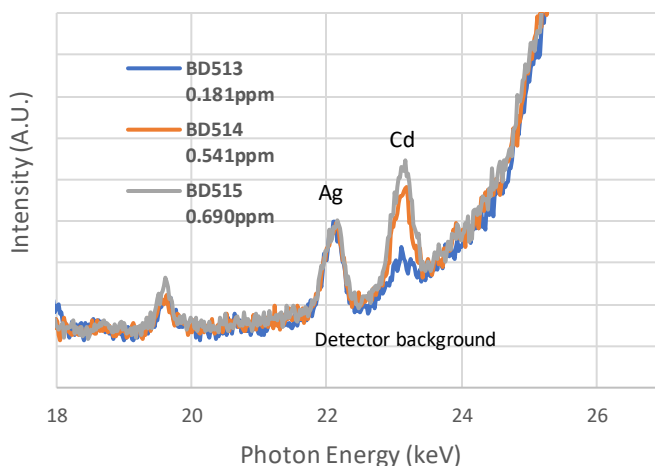
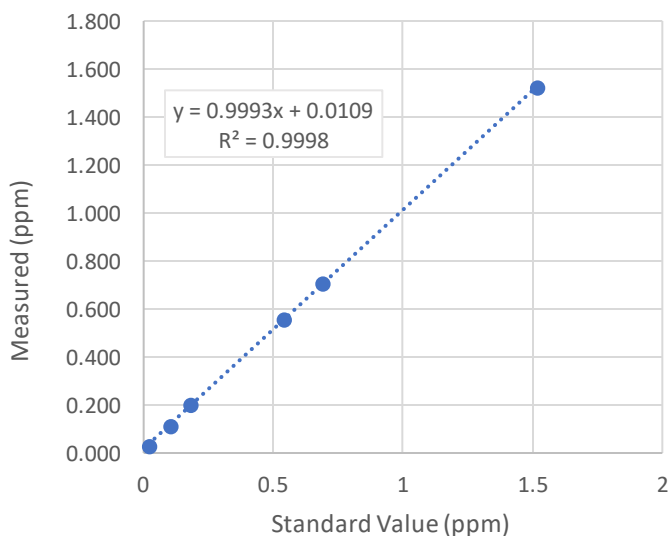


Figure 2. Cd calibration curve in E-max



### Fundamental parameters (FP) approach

E-max applies the 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 improve accuracy for specific sample types. Figure 2 shows a Cd calibration in E-max using reference materials.

## Precision and Accuracy

The precision and accuracy are evaluated using the ERM reference materials BD513, BD514, and BD515. Each measurement only takes 200s. Improved precision can be obtained by averaging two successive measurements.



Reference material	ERM BD513	ERM BD514	ERM BD515
Certified Cd Value (ppm)	0.181	0.541	0.690

### Single point 200s results (ppm)

	BD513	BD514	BD515
1	0.175	0.553	0.703
2	0.168	0.554	0.644
3	0.173	0.529	0.705
4	0.231	0.552	0.670
5	0.154	0.554	0.661
6	0.212	0.493	0.706
7	0.192	0.529	0.622
8	0.166	0.587	0.731
9	0.175	0.519	0.712
10	0.191	0.538	0.727
<b>Average</b>	<b>0.184</b>	<b>0.541</b>	<b>0.688</b>
<b>SD</b>	<b>0.023</b>	<b>0.025</b>	<b>0.037</b>
<b>RSD</b>	<b>13%</b>	<b>5%</b>	<b>5%</b>

### Average of two points 200s results (ppm)

	BD513	BD514	BD515
1	0.172	0.553	0.673
2	0.171	0.541	0.674
3	0.202	0.540	0.687
4	0.192	0.553	0.666
5	0.183	0.523	0.683
6	0.202	0.511	0.664
7	0.179	0.558	0.676
8	0.171	0.553	0.721
9	0.183	0.528	0.719
<b>Average</b>	<b>0.184</b>	<b>0.540</b>	<b>0.685</b>
<b>SD</b>	<b>0.013</b>	<b>0.016</b>	<b>0.021</b>
<b>RSD</b>	<b>7%</b>	<b>3%</b>	<b>3%</b>

## Correlation with ICP testing

Cocoa beans were ground into a powder-type sample. The ground cocoa bean powder was placed into a sample cup, and then tested by E-max. Each batch of cocoa bean powder had three specimens prepared and tested with 200s measurement. The average of the three results was used as the determined Cd level of the cocoa beans. The same batch of powder was also tested using the ICP-MS method. Figure 3 shows the high consistency of results obtained from E-max and ICP. Cocoa powder was directly placed into a sample cup for testing while cocoa liquor was heated first and then placed into a sample cup for testing. The Cd content results in cocoa powder and cocoa liquor obtained from E-max and ICP were also highly consistent, as demonstrated by Figure 4.

Figure 3. Cd contents in the cocoa bean

-- E-max vs. ICP

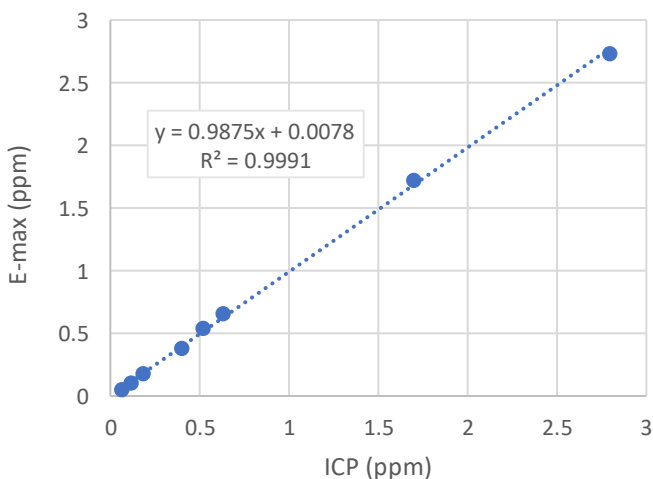


Figure 4. Cd contents in the cocoa powder and cocoa liquor -- E-max vs. ICP

-- E-max vs. ICP

