LA-ICP-MS Imaging of Element Distribution in Food Grains

Introduction

Food safety begins with knowing what's inside. Even trace amounts of toxic metals like arsenic (As), cadmium (Cd), mercury (Hg), and lead (Pb) can pose health risks. While traditional ICP-MS is effective for detecting low concentrations, it cannot reveal **where** metals are located within the food.

Laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) fills this gap—combining high sensitivity with spatial resolution to map metal distribution directly in solid samples, without digestion. This enables more informed decisions across the food production process—from cultivation to packaging.

In this study, we showcase LA-ICP-MS imaging of As, Cd, Pb, and Ni in **brown rice, beans, and chickpeas**, demonstrating how the technique enhances food safety through precise, localized contamination analysis.

Analyses were conducted using a **Teledyne Iridia 193 nm excimer laser** with a **Cobalt cell**, coupled to an **Agilent 8800 ICP-QQQ-MS**. Elemental imaging was performed using **HDIP software v1.8.5.148**.

Bean Samples

Our analysis revealed **low levels of arsenic and lead** in bean samples, with **lead predominantly located on the outer surface** of the grain—critical information for post-harvest processing strategies. In addition, **nickel was detected at parts-per-million (ppm) levels**, showing a clear **enrichment near the outer layers** of the beans (Figure 1).

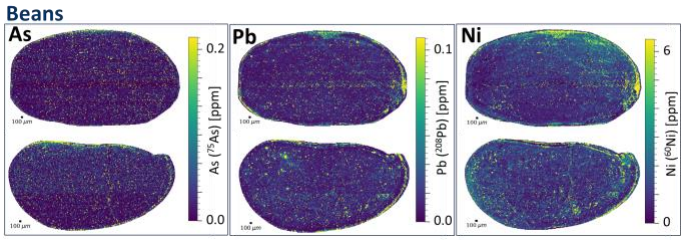

Figure 1. High-resolution laser ablation images showing the spatial distribution of arsenic (As), lead (Pb), and nickel (Ni) in bean samples.

Lentil Samples

Figure 2 presents LA-ICP-MS elemental maps of arsenic (As), lead (Pb), cadmium (Cd), and nickel (Ni) in lentil grains.

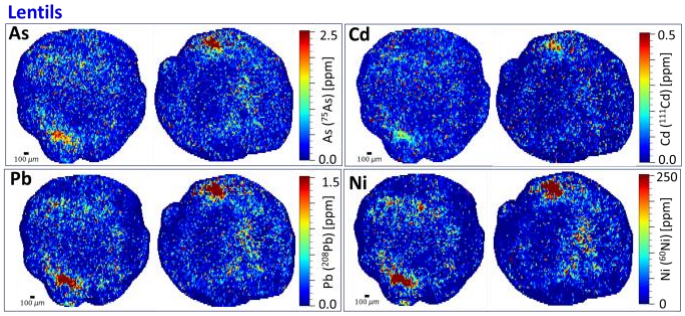

Figure 2. LA-ICP-MS images of As, Pb, Cd, and Ni in lentil samples, showing surface-localized trace metals.

Chickpea Samples

Trace levels of As, Pb, and Cd were detected in chickpea grains, with localized areas showing slightly elevated Pb. Ni was present at ppm levels, mostly homogeneously distributed with minor surface enrichment. **Figure 3** shows the spatial distribution of these elements, highlighting LA-ICP-MS as a powerful tool for food safety monitoring.

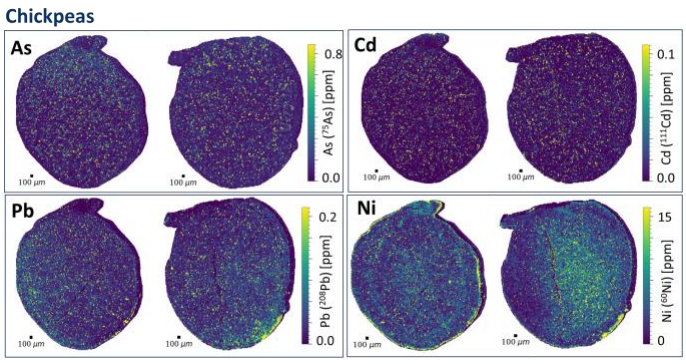

Figure 3. High-Resolution LA-ICP-MS Imaging of As, Pb, and Cd in Chickpea Samples

Brown Rice Samples

Elemental mapping of brown rice-1 and brown rice-2 reveals clear **arsenic (As) enrichment in the outer layers** (tens of micrometers) and elevated lead (Pb) levels at the grain tips. **Figure 4** shows the spatial distribution of As and Pb, demonstrating the precision of LA-ICP-MS in detecting contamination zones in rice grains.

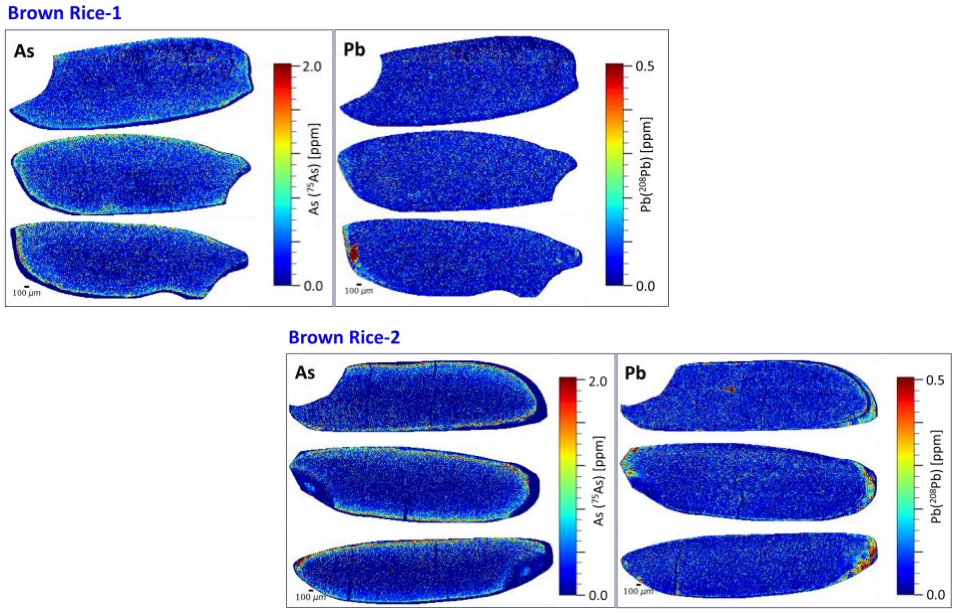

Figure 4. LA-ICP-MS Imaging of Arsenic (As) and Lead (Pb) in Brown Rice Grains

References

1. Van Malderen, S. J., Van Acker, T., & Vanhaecke, F. (2020). Analytical Chemistry, 92(8), 5756-5764.
2. Norton, G., Deacon, C., Mestrot, A., Feldmann, J., Jenkins, P., Baskaran, C., & Meharg, A. A. (2013). Environmental science & technology, 47(12), 6164-6172.