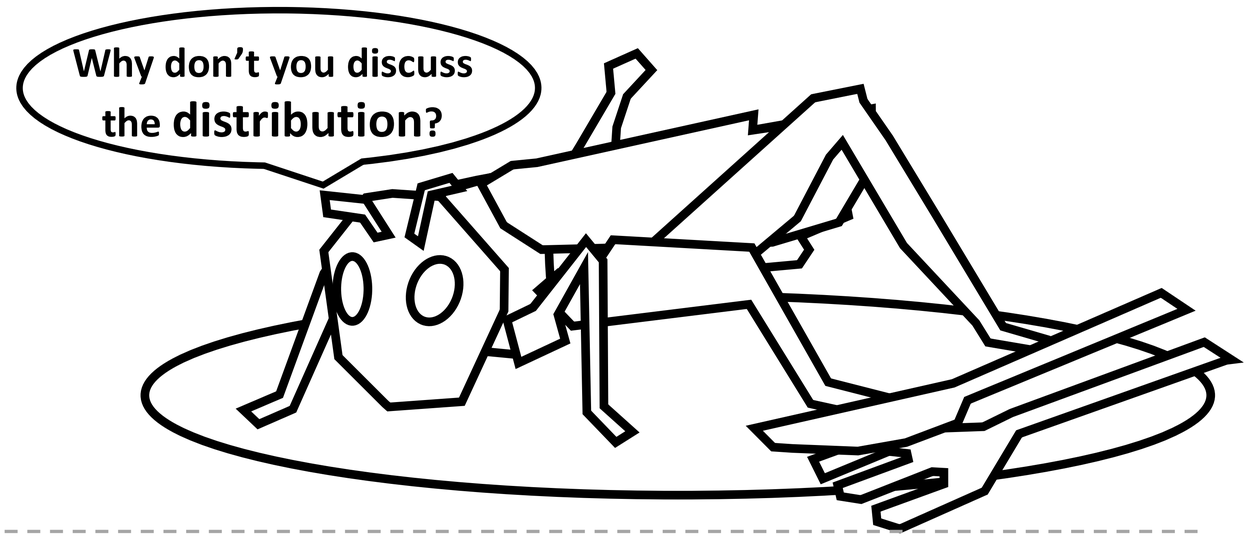
Micro-XRF imaging reveals the distribution of inorganic elements inside edible crickets

Chiya NISHIMURA[1], Yuka Yanai[1], Shunsuke Murata[1], Sofia GAIASCHI[2] ([1]HORIBA, Ltd., Japan, [2]HORIBA FRANCE SAS, France)

1. Motivation

Elemental analysis is significant for better understanding of edible insects from nutritional and toxicological perspectives. ICP-OES and XRF have been popular elemental analysis to determine total contents of inorganic elements in insects.[1,2] However, there is no report that discuss the distribution of the elements even though they are often eaten as they are without ground into powder.

In this poster, we introduce micro-XRF as an elemental imaging tool to visualize the distribution of inorganic elements in an insect body.

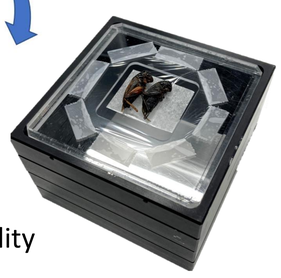


2. Sample information

a pack of edible crickets from an entomophagy shop

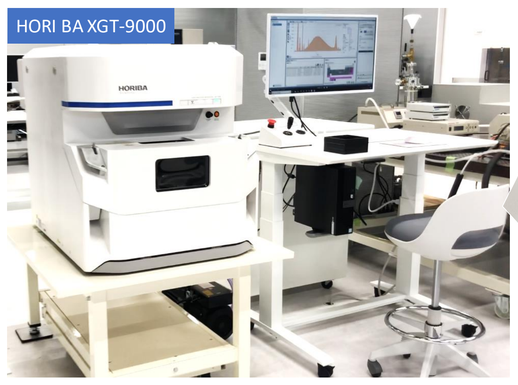
- Country of origin: Japan
- Feed: Almond
- Process: Roasted
- Flavoring: Nothing
- Size: approx. 30 mm

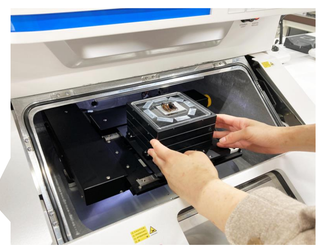
Select **2** of them to check the repeatability



3. Method

What is micro-XRF? How does it work?





Method: micro-XRF*

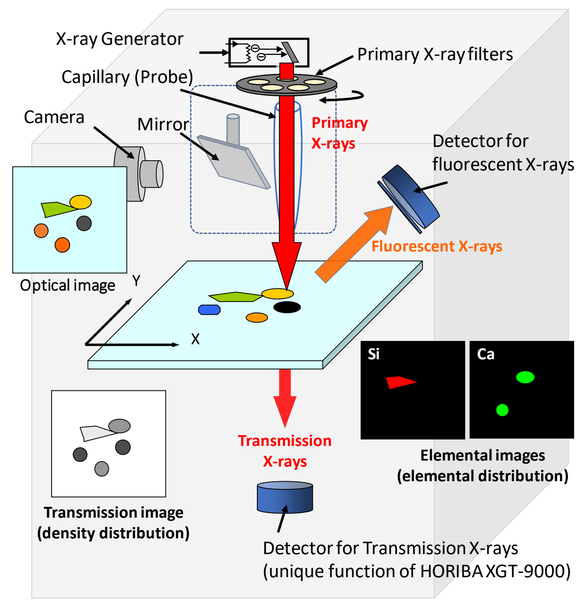
*It is a non-destructive elemental analysis technique based on energy dispersive X-ray fluorescence spectroscopy with a micron spot size. Thanks to the motorized XY stage, it allows distribution imaging in microscopic level.

Instrument name: XGT-9000 X-ray Analytical Microscope (HORBA, Ltd.)

Sample setting: Put them on a tape on a film*

*We fixed them on a special sample tray (hole in the center) to reduce the background signals derived from scattered primary X-rays.

Condition: 50 kV, 1000 µA, Rh target, Partial vacuum mode

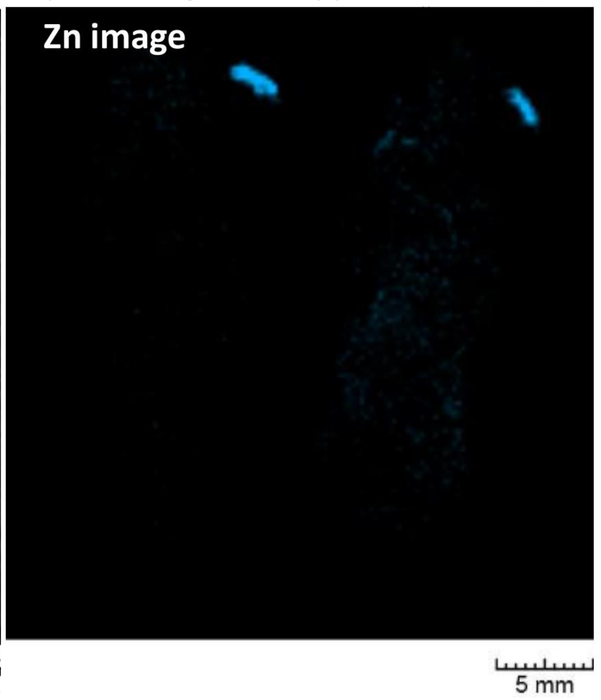


Schematic diagram of XGT-9000

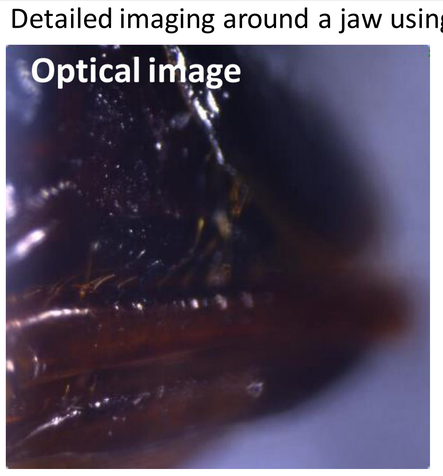
4. Result

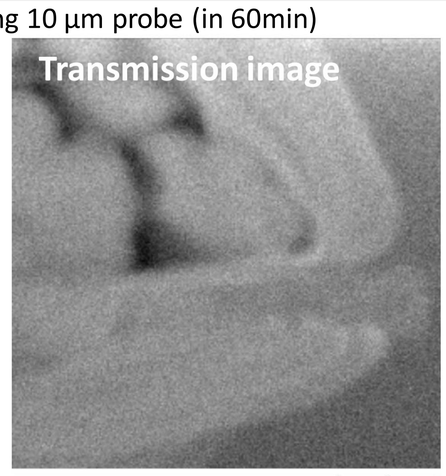
The below results show the optical images, the transmission X-ray images, and the Zn images on the crickets using a HORIBA XGT-9000.

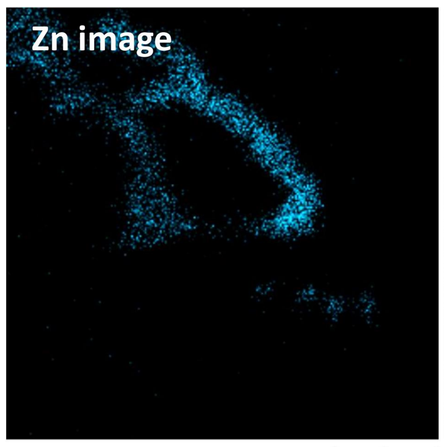
Entire imaging covering the two crickets using 100 µm ultra-high intensity probe (in 10 min)

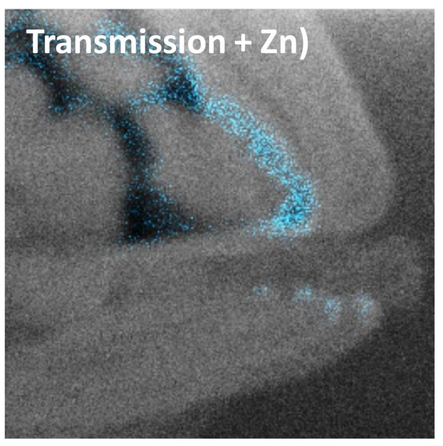


Detailed imaging around a jaw using 10 µm probe (in 60min)



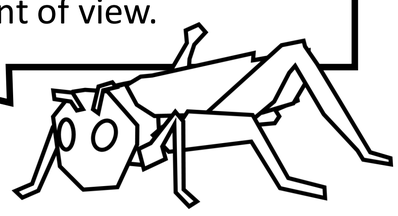






*Comment: The other elements didn't have any specific enrichment in the crickets. Therefore, they are not displayed here.

Micro-XRF imaging results show **Zinc enrichment in a jaw** of both crickets. Our result was consistent with previous research reporting Zn enrichment in the jaws of grasshoppers[3], worms[4], and a dragonfly[5] from the biological point of view.



5. Conclusion

Our result shows the importance of micro-XRF imaging to know if an element has any distribution in an edible insect or just exists homogeneously inside. HORIBA XGT-9000 Analytical Microscope, which has dual detectors for fluorescent X-rays and transmission X-rays, can visualize where the enrichment exists without sample pretreatment and sample destruction. It can contribute to the further spread and understanding of entomophagy.

6. Further challenges

- Collect the data of more various edible insects
- Possibility to convert the X-ray signal counts into concertation of an element

7. Reference

[1] Ghosh et al. (**2017**) *J. Asia Pac. Entomol.,* 20 (2) pp.686-694.
[2] Aydoğan et al. (**2021**) *Int. J. Trop. Insect Sci.* 41, pp.3049-3054.
[3] Laiolo et al. (**2021**) *Evolution*, 75 (5) pp.1132–1142.
[4] Lichtenegger et al. (**2003**) *Proc. Natl. Acad. Sci. USA.,* 100 (16), pp.9144-9149.
[5] Nakamura et al. (**2017**) *Adv. X-Ray. Chem. Anal., Japan,* 48, pp.365-374.