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Elemental Distribution Imaging on Edible Insects Using Micro-XRF

Application Note

Food
XGT25

Chiya Nishimura[1], Yuka Yanai[1], Tomoki Aoyama[1]
[1]HORIBA Co., Ltd, Japan

Abstract: Edible insects have received attention as a possible solution as a supplemental source to reduce food insecurity because of their nutritional benefits such as protein, fat, and minerals. Micro-XRF can be used to understand the elemental distributions in insects non-destructively. In this application note, we carried out elemental map imaging on edible crickets using a HORIBA XGT-9000 X-ray analytical microscope and revealed the rich source of zinc in their jaws.

Keywords: Entomophagy, edible insects, inorganic nutrients, elemental distribution imaging, micro-XRF

Introduction

Food insecurity is one of the most important social crises we face today. The Food and Agriculture Organization of the United Nations estimated that between 720 and 811 million people faced hunger, and that the prevalence of undernourishment (PoU) climbed to around 9.9 percent in 2020 in the world.[1] As a breakthrough of the crisis, edible insects have received attention and many scientific research studies have been conducted to reveal their nutritional benefits, such as protein and minerals.[2,3]

Elemental analyses are significant for better understanding of edible insects from nutritional and toxicological perspectives. ICP-OES and XRF are widely used as screening tools to determine total contents of inorganic elements in insects.[2,3] In addition, micro-XRF can reveal the distribution of the elements in insects non-destructively by scanning the stage during measurement.

Since such elements often have distribution in an insect body because of metabolism[4,5], it is important to know the distributions of "what elements exist in which parts of an insect" as well as total content of the elements

In this application note, we carried out elemental map imaging on commercial edible crickets using the HORIBA XGT-9000 X-ray analytical microscope (Figure 1) to reveal the distribution of a metal nutrient, zinc, in them.

Sample information

We purchased a pack of edible crickets (Figure 2) from an entomophagy shop. The cricket was fed and processed (roasted without any flavoring) by a manufacturer in Japan. The cricket size was approximately 30 mm, and the edible crickets are known to contain a good amount of zinc.

Figure 1. HORIBA XGT-9000 X-ray analytical microscope.

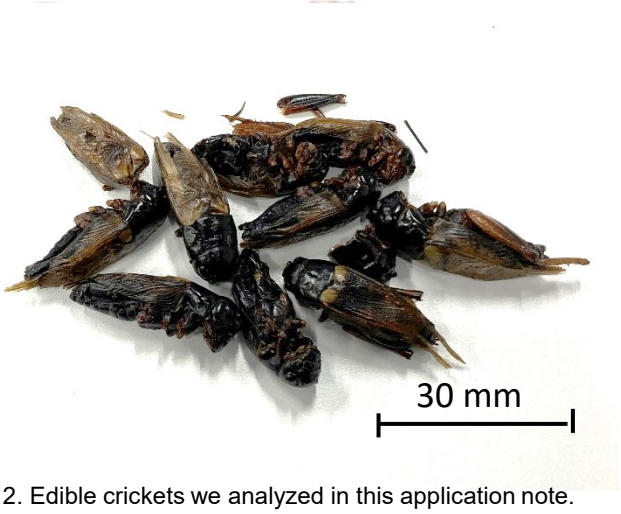

Figure 2. Edible crickets we analyzed in this application note.

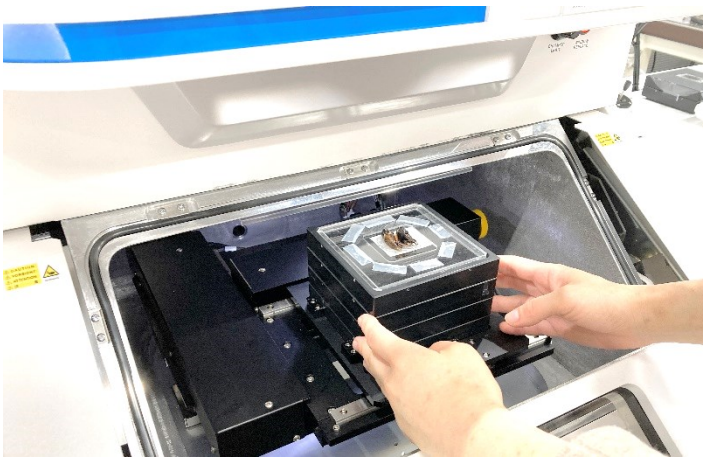

Figure 3. Sample setting into the chamber of the XGT-9000.

Method

We analyzed two crickets to check the repeatability. We fixed them on a special sample tray to reduce the background signals derived from scattered primary X-rays, and we set them into the chamber of the XGT-9000 (Figure 3). We didn't perform any other sample pretreatments, like oven-drying process.

We carried out elemental map imaging on the crickets using the XGT-9000 with a 100 μm ultra-high intensity probe in 10 min. The voltage and current of the X-ray generator were set to 50 kV and 1000 μA, respectively. The measurement was done under "partial vacuum" mode, where a thin film separates the optics (under vacuum condition) and the sample chamber (under ambient condition). The thin film window protects the instrument from damage cause by inherent water in a sample, which easily evaporates during a measurement.

Result

Figure 4 shows the result of elemental map imaging by the XGT-9000. It shows an optical image, distribution image of zinc, and the layered image. The result shows the zinc enrichment in a jaw of both crickets. Our repeatable result was consistent with previous research reporting zinc enrichment in the jaws of worms[4] and grasshoppers[5] from the biological point of view.

Conclusion

Thanks to the high penetration of primary X-rays and partial vacuum mode, the XGT-9000 details elemental distributions of metal nutrients in insects without sample pretreatment and sample damage non-destructively. Thus, the XGT-9000 provides a better understanding on edible insects, and it can contribute to the further spread of entomophagy.

Reference

[1] FAO：The State of Food Security and Nutrition in the World 2021. The world is at a critical juncture (2022/01/10 https://www.fao.org/state-of-food-security-nutrition/en/)

[2] Ghosh et al (**2017**) Nutritional composition of five commercial edible insects in South Korea, J. Asia Pac. Entomol., 20 (2) pp.686-694.

[3] Aydoğan et al (2021) Two new edible insect species from Ghana and their chemical content evaluation. Int. J. Trop. Insect Sci. 41, pp.3049-3054.

[4] Lichtenegger et al. (**2003**) Zinc and mechanical prowess in the jaws of Nereis, a marine worm. Proc Natl Acad Sci U S A., 100 (16), pp.9144-9149.

[5] Laiolo et al. (**2021**) Selection for functional performance in the evolution of cuticle hardening mechanism in insects. *Evolution,* 75(5) pp.1132–1142.

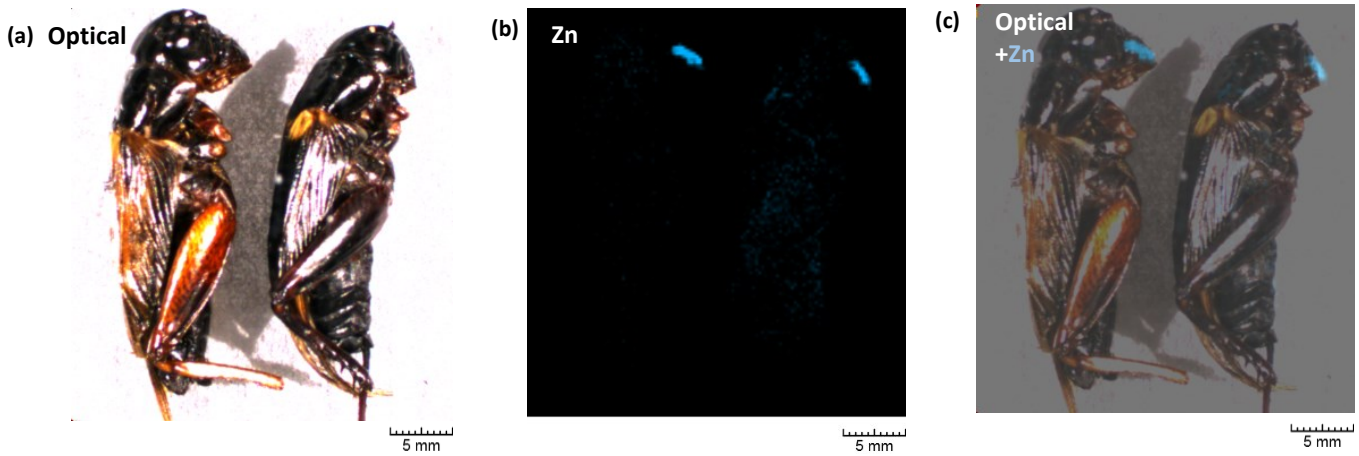

Figure 4. Elemental map imaging on the crickets by the XGT-9000 (a) optical image (b) Zinc image (c) layered image.

info.sci@horiba.com

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USA: +1 732 494 8660
UK: +44 (0)1604 542 500
China: +86 (0)21 6289 6060
Taiwan: +886 3 5600606
France: +33 (0)1 69 74 72 00
Italy: +39 06 51 59 22 1
India: +91 (80) 4127 3637
Brazil: +55 (0)11 2923 5400
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