Molecular Speciation and Intracellular Localization of Fatty Acids Labeled with a Single Element

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Introduction

Fatty acids are efficient energy sources by themselves and are components of cellular membranes. These versatile functions are essential for cell growth, movement and survival, and they are also related to diseases. The analysis of the metabolism of fatty acids into lipids *e.g.* glycerophospholipids and neutral lipids, has been well studied by chromatography and mass spectrometry. However, the imaging of fatty acids in cells has not been successful, using conventional methods. Labeling with large moieties as chromophores may interfere with metabolism. Isotope labeling of fatty acids, in combination with positron emission tomography and matrix-assisted laser desorption/ionization mass spectrometry, are inadequate to image fatty acids in cells, owing to their low resolution. To overcome this issue, we employed the single-element labeling of fatty acids, combined with synchrotron X-ray fluorescence technology.

Methods

Br-palmitic acid (PA) and Br-stearic acid (SA) were prepared, both of which possess a Br at position 12. Cells were treated with Br-SA for 24 hrs. Analyses using inductively coupled plasma mass spectrometry and LC-MS, combined with column separation, were performed to understand the metabolism of Br-PA and Br-SA in cells. For imaging, cells were subjected to scanning X-ray fluorescence microscopy (SXFM) at BL29XUL, SPring-8.

Results and Discussion

We imaged the incorporation and localization of Br-labeled PA and SA by SXFM. Our results characterized the molecular homeostasis of fatty acids, particularly their incorporation into glycerophospholipids. Moreover, the high-resolution X-ray fluorescence images facilitated the complete characterization of associated intracellular processes (1,2).

Conclusion

The application of our new technology to unsaturated fatty acids will contribute to understanding the dynamics of eicosanoids and other polyunsaturated fatty acid, derived lipid mediators in various fields of physiology and pathology, including inflammation, neurodegenerative disease, and cardiovascular disease (1,2).

Literature:

(1) Shimura M., *et al.* Imaging of intracellular fatty acids by scanning X-ray fluorescence microscopy. *FASEB J*. 30, 2016.
(2) Shimura, M., *et al.* Visualization of Intracellular Elements Using Scanning X-Ray Fluorescence Microscopy. in Metallomics: Recent Analytical Techniques and Applications (eds. Ogra, Y. & Hirata, T.) 63–92 (Springer Japan, 2017).