From supplements to wine: element speciation and chemical imaging for food research at SOLARIS

Maximenko Alexey[1], Kosowska Karolina[1] and Sławek Joanna[1]
[1]*SOLARIS National Synchrotron Radiation Centre, Jagiellonian University, Czerwone Maki 98, 30-392 Kraków, Poland*

In food science, quality, safety and nutritional value often depend less on how much of an element or compound is present than on its chemical form and spatial distribution. Synchrotron techniques address this directly, complementing chromatographic and mass-spectrometric food analysis. This contribution presents SOLARIS (Kraków, Poland) [a], a CERIC partner facility, focusing on two beamlines. ASTRA provides XANES/EXAFS in the tender and hard X-ray range, with performance optimized between 1.8 and 12 keV, for element-specific speciation in powders, plant tissues and dilute samples. CIRI combines FT-IR microspectroscopy, O-PTIR and AFM-IR/s-SNOM for label-free chemical imaging from the micro- to the nanoscale.
Selected user cases will be shown. At ASTRA [b], Mg and Zn K-edge XANES distinguished Mg forms in dietary supplements and dark chocolate, and showed that Zn sulfate and Zn gluconate supplements both converge to hydrated Zn^{2+} under simulated gastric conditions. Fe K-edge XANES of *Arthrospira* and *Chlorella* biomass revealed more ferrihydrite-like FeOOH in laboratory-fortified samples and more organically coordinated iron in commercial products, which may partly explain the higher iron bioaccessibility of the latter. Cl K-edge XANES of porous adsorbents exposed to 2,4,6-trichloroanisole, the cause of cork taint in wine, indicated retention without major alteration of the molecule. Ca, Fe and S XANES of *Euphorbia milii* callus probed element speciation under drought stress and exposure to fullerenes and phytohormones. At CIRI, infrared imaging mapped lipids, proteins and carbohydrates in 18th-century chocolate and identified micro- and nanoplastics in bottled water and human tissues [c].
Finally, the SOLARIS Agro&Food Hub will be introduced, aiming at coordinated, user-oriented access to complementary infrastructures for agri-food research.

References

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Short bio:

Alexey Maximenko is the Beamline Coordinator of the ASTRA X-ray absorption spectroscopy beamline at the SOLARIS National Synchrotron Radiation Centre, Jagiellonian University, Kraków. He is also the Director's Representative for Scientific Collaboration and coordinates the SOLARIS Agro&Food Hub. He received his PhD in physics from the Institute of Nuclear Physics PAS. His work focuses on XANES/EXAFS methodology, including in-situ/operando experiments, and on supporting users in materials science, catalysis, energy, environmental and agri-food research. He represents SOLARIS in EU projects such as RIANA and in international light-source initiatives such as PALSA.