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Claire Bourlieu-Lacanal, Amélie Deglaire, Olivia Ménard, Thomas Croguennec, Stephane Pezenec, Juliane Floury, Steven Le Feunteun, Pierre Villeneuve, Frédéric Carrière, Didier Dupont, et al.

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4 D (x, y, z, t) imaging of digestive lipases during simulated neonatal gastro-intestinal digestion of milk fat globules or biomimetic emulsions using synchrotron SOLEIL DISCO beamline

BOURLIEU^{1,3*}, C. ; DEGLAIRE¹, A. ; MÉNARD¹, O. ; CROGUENNEC¹, T. ; PEZENNEC¹, S. ; FLOURY¹, J. ; LE FEUNTEUN², S. ; VILLENEUVE³, P. ; CARRIERE⁴, F. ; DUPONT¹, D. ; BOUHALLAB¹, S. ; JAMME⁵, F. ; VIÉ⁶, V.

¹INRA-Agrocampus Ouest UMR 1253 STLO - France; ²UMR 782 INRA-AgroParisTech GMPA - France; ³CIRAD/INRA, UMR 1208 IATE - France; ⁴CNRS, Aix Marseille University, UMR 7282 Interfacial Enzymology and Physiology of Lipolysis - France; ⁵Synchrotron SOLEIL - France; ⁶IPR Institute of Physics, Rennes University 1 - France

*claire.bourlieu-lacanal@inra.fr

In their native state, milk lipids are present in the form of dispersed droplets called Milk Fat Globules (MFG, average diameter of 4 μm in human and bovine milks), which have been recently pointed out as key elements of early nutritional programming. Understanding the specific digestive fate of MFG is thus a priority in neonatal nutrition. The MFG are unique biophysical elements differing from other lipoproteic objects by their external trilayered membrane inherited from their secretory past. To play their major biological function, i.e. deliver energy to the newborn, the MFG have to be hydrolyzed in the gastro-intestinal tract by lipases. This hydrolysis is typically a heterogeneous phase reaction, in which the lipase has to diffuse and get adsorbed onto the lipid phase before the formation of the enzyme-substrate complex, and the onset of the proper catalytic action.

Very few techniques allow assessing the mechanisms involved in the enzymatic hydrolysis of complex supramolecular substrates such as MFG. To get a better insight of these mechanisms, 4-D imaging of gastric and pancreatic lipases enzymes using synchrotron SOLEIL UV fluorescence microscopy was applied during simulated static in vitro newborn digestion. This methodology allowed mapping the adsorption and diffusion of lipases onto/within human or bovine MFG or biomimetic droplets devoid of membrane proteins. These data were completed with simultaneous transmission light imaging of MFG disintegration during

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hydrolysis.

The high sensitivity of the DISCO beamline allowing the detection of digestive lipases auto-fluorescence, is a unique tool to unravel their mechanisms of adsorption onto complex substrate using free-label imaging and has generated useful data for infant formula optimization.

Keywords: synchrotron; lipase detection label-free; neonatal fat digestion

For oral presentation

For poster presentation