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Mechanism of adsorption of gastric lipase in model membranes of milk fat globules

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Lipid digestion is initiated in Human by gastric lipase. Lipolysis of complex lipoproteic assemblies such as milk fat globules, based on an apolar core of triacylglycerides enveloped by a trilayered membrane, is particularly frequent during neonatal digestion¹. Such lipolysis proceeds at acid pH and requires a rapid adsorption onto the substrate membrane before the onset of catalytic activity². The interactions governing this adsorption are not fully elucidated. Our objective was thus to unravel these interactions and precise gastric lipase lateral distribution in model membranes of milk fat globules presenting liquid phase segregation.

Ellipsometry, tensiometry and atomic force microscopy were used to get an insight on the ability to the lipase to get inserted into the lipid membrane³. Lipid Langmuir films were used to mimic the outer leaflet of the external membrane of the milk fat globule. Different lipid mixtures or natural extracts of cow buttermilk with variable physical phases, surface charge and lateral packing were tailored to identify the nature of the enzyme/membrane interactions. Recombinant dog gastric lipase (rDGL) was used as model of the human gastric lipase.

This combination of biophysical tools indicated that: 1. rDGL is characterized by a high affinity for the lipid/liquid interface with large amount of molecules located close to the interface but limited insertion; 2. rDGL partitions toward liquid expanded phase and at phase boundaries, gets adsorbed at three height levels and strongly impacts on lipid phase lateral organization; 3. besides hydrophobic interactions, rDGL adsorption is favored by electrostatic interactions which were investigated through surface potential modelling; addition of local negative charges using phosphatidylserine reinforced adsorption.

The massive amount of gastric lipase located close to the substrate may favor rapid prelipolysis before gastric emptying and subsequent action of pancreatic lipases. Generalization of this biophysical approach to other digestive lipases to precise their interaction with complex food substrate is very promising.

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