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Multi-scale characterization of *in vitro* and *in vivo* digested foods

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Context

Digestion of nutrients is an essential function for human to allow normal growth and development.

During digestion, the structure of the ingested food evolves and detailed characterization of the digestion products is essential for a better understanding on how food is disintegrated in the gastro-intestinal tract.



Objectives

Development of tools which allows the characterization of the components of the matrix during the disintegration that occurs in the human gastro-intestinal tract.

Why opting for a multi-scale characterization ?

Molecular scale

- to identify and/or quantify **molecules** released during digestion
- to estimate the rate and the kinetic of hydrolysis of the protein and lipids

Macro & Mesoscopic scale

- to understand how the **structure** of the matrix evolves in the gastro-intestinal tract

Methods

Macroscopic scale



Rheology :

Oscillation procédure
Simulation of a gastric digestion (decrease of pH + gastric enzymes) in a rheometer to predict the food gastric behaviour

Microscopic scale



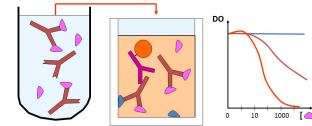
Laser light scattering :

Measurement of the particles sizes distributions (at different stages of the digestion)



Confocal microscopy :

Using different fluorescent probes, the evolution of the structure of proteins and lipids can be evaluated



Molecular scale

Elisa by inhibition :

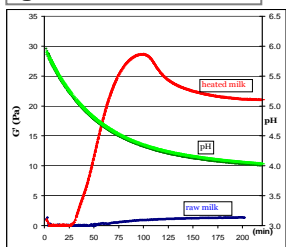
Quantification of intact proteins, measurement of the proteolysis kinetic

Mass spectrometry :

Identification of the peptides
SDS-Page :
Qualitative monitoring of the proteins digestion :
-decrease of intact proteins
-appearance of peptides

Applications

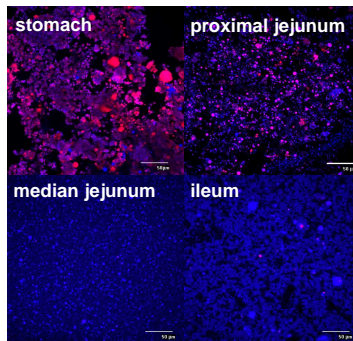
in vitro milk gastric behaviour



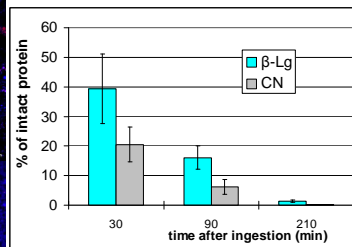
Monitoring of G' (solid resistant of the gel) on a skim milk during a simulated digestion

> **Discrimination of different processed milks based on their potential gastric behaviour**

in vivo digestion of milk formula by piglets

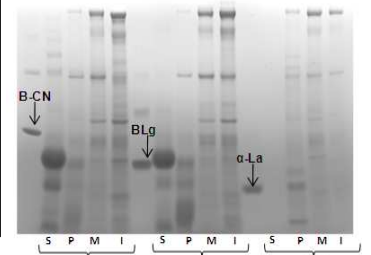


Microscopy confocal
2 fluorophores : Nile red for lipids and Nile blue for proteins (X 40)
> **Evaluation of the disintegration in the gut**



Elisa : quantification of the 2 different milk proteins during gastric digestion

> **Quantitative evaluation of the proteolysis**



SDS-PAGE on effluents from: S (stomach, P (proximal jejunum), M (median jejunum and I (ileum) at 30, 90 and 210 min after the last meal.
> **Qualitative evaluation of the proteolysis**

Conclusion

By combining methods, disintegration of the food and kinetics of hydrolysis are evaluated. This multiscale approach allows a better understanding of the mechanisms of digestion of complex food matrices