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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?

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

Methods

Macrosopic scale

- Rheology: Oscillation procedure
  - 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
  - Elisa by inhibition:
    - Quantification of intact proteins, measurement of the proteolysis kinetic
- Mass spectrometry:
  - Identification of the peptides

Molecular scale

- Elisa by inhibition:
  - Quantification of intact proteins, measurement of the proteolysis kinetic
- 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

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.