in vitro digestion of a bread and cheese meal as dynamically and non-invasively investigated by Magnetic Resonance Imaging

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Background and objective: Magnetic Resonance Imaging (MRI) is a highly promising non-invasive approach for both in vivo and in vitro digestion researches as it can provide information on the status and amount of water and lipid protons throughout the enzymatic breakdown of food(s). These information can be used for spatially resolved measurements of multi-scale structural features and composition of simplified or complex food products. The combination of foods (bread, cheese and water) and the non-invasive monitoring of digestion both in vitro and in vivo are two innovative research fronts in this area.
Method: The meal consisted of bread and cheese (24% lipids, 33% proteins, and 43% carbohydrates) added with water, and using in vivo realistic boli particle size distributions (range: 0-5 mm). The erosion of large praticles, the hydrolysis of nutrients, as well as the creaming of lipids were studied by low-field MRI (1.5 T) using an adapted version of the semi-dynamic gastrointestinal INFOGEST protocol.
Results: Combining different MRI image modalities, it was possible to investigate separately several phases of the digesta, i.e. supernatant, large cheese and bread crust pieces, and the deposit of small fragments at the bottom of the vessel. Changes in their volume, NMR relaxation parameters and lipid amount were discussed together and related to variations in pH, enzymatic activity and composition.
Conclusions: Low-field MRI allows to monitor dynamically and non invasively the process of imbibition, creaming and erosion in bread and cheese particles of which largest size was initially in the order of a few mm. Further research is needed however to relate NMR parameters to the molecular size and pH.