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Neutron scattering for the study of casein gel microstructure during digestion

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An understanding of the structural factors that affect food digestion kinetics is important for establishing the relationship between their structure and function. To assess the effects of structure on mechanical breakdown and digestibility by pepsin enzyme during gastric digestion, casein gels with an identical composition, but differing by the coagulation mode, were characterized and submitted to simulated in vitro gastric digestion. Rennet-induced (RG) and transglutaminase-induced acid (TG) gels were made and digested in two different solvents - H2O and D2O. The structural changes were assessed during simulated gastric digestion by ultra-small (USANS) and small angle neutron scattering (SANS).

The different structures of RG and TG reveal distinctive breakdown behaviours over a hierarchy of length scales (nano- to micro). Different functional properties of casein gels, such as gel strength, elasticity, brittleness, resistance to shear and sensitivity to the acidic environment of gastric phase, obtained by scanning (SEM) and transmission electron microscopy (TEM), contributed to the differences in gel disintegration and gastric digestibility. Despite the higher gel strength and thus higher number of larger gel particles entering the gastric phase following mastication, the porous microstructure of RG provided a larger surface area and thus higher simulated digestibility compared to TG. The effect of acidification is clearer with RG, wherein the local compactness of each gel consequently drives its porosity and pepsin accessibility. On the other hand, pepsin has a limited diffusion capability inside the TG structure due to its fine stranded network; however, the brittle structure of TG is more affected by mechanical shear during the gastric phase, causing particle erosion. In a similar manner, gels made and digested in D2O had a higher level of mechanical breakdown due to their brittle structure: initially led by the fracturing of particles with a larger surface area, this increases the levels of solubilised protein, small peptides and amino acids.

Here, we report the first USANS and SANS study to monitor structural changes of a casein gel both in H2O and D2O during simulated in vitro gastric digestion. We show that solvent (H2O and D2O) and gel type (RG and TG) affects digestion components: mechanical shear, enzymatic hydrolysis and the effect of acidification.

Speakers Gender

Female

Level of Expertise

Student

Do you wish to take part in the poster slam

Yes

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