Experimental report

31/08/2022

Proposal:	**9-13-982**	**Council:**	10/2020
Title:	Probing gluten versus gluten-free pasta using small-angle neutron scattering with contrast variation		
Research area:	Other...		

This proposal is a new proposal

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Samples: pasta

Instrument	Requested days	Allocated days	From	To
D11	2	1	14/06/2021	15/06/2021
D33	0	0		

Abstract:

Scattering techniques have been used to unravel the structure of starches samples but so far these techniques have not been employed a the full of their potential in food science. The case of pasta is emblematic, confocal microscopy highlighted how the presence of a continuous gluten matrix is a fundamental characteristic that determines the fact that the assumption of pasta results in only a small increase in sugar released in the blood. The structures formed were directly related to the kinetics of digestion and have a central role on the metabolic process. Our goal is to understand the effects of using gluten-alternatives on the micro- and macro-structure of pasta, and then eventually relate these to their role in digestion. SANS with contrast variation will be used to study the internal structure of commercial- and gluten-free pasta. The structures will be characterized before and after cooking, and with different amounts of salt in the water used to cook the pasta. By means of scattering and contrast variation we aim to relate the macroscopic properties with microscopic structural differences depending on the presence of gluten and on the cooking conditions.

By using mixtures of water/heavy water it is possible to match the scattering length density (SLD) of the different components composing the pasta samples and render them almost invisible to the neutron beam. Initially, the regular pasta was measured in different mixtures of D_2O/H_2O to contrast match features arising from the gluten matrix and starch granules.

At 42 wt% D_2O we believe the gluten matrix is most well-matched. This value roughly corresponds to a SLD of ~2 x 10^{-6}A^{-2}, as reported in the literature, and is supported by the fact slope of this sample at low-q scales as ~ $q^{-3.6}$, as expected from the scattering of quasi-spherical starch granules. Unfortunately, we were unable to match out the characteristic peak of the starch lamellae at any contrast. This may be due to the lack of permeability of the water/heavy water within the starch granules, the inhomogeneous nature of the starch granules themselves, e.g. crystallinity and size, or that there is another contribution to the scattering at this length-scale we have not considered. Interestingly though, a small upturn/peak at q = 0.5 A^{-1} was observed in 100 wt% D_2O. With this is in mind, SANS measurements of both types of pasta were performed in D_2O/H_2O mixtures containing 100, 42 and 0 wt % D_2O, Figure 1. In all contrasts, we observe the characteristic starch peak at 0.06 A^{-1}, which is lost as a function of cooking time. The slopes at low q in pure H_2O and pure D_2O, drop from q^{-3} to $\$q^{-2.5}$ and $q^{-3.3}$ to q^{-3}, respectively. This corresponds to the grow-in of gluten network, and an increase in surface roughness. In 42 wt% D_2O, we can fit the profiles to that of the starch granules, as a function of cooking time.

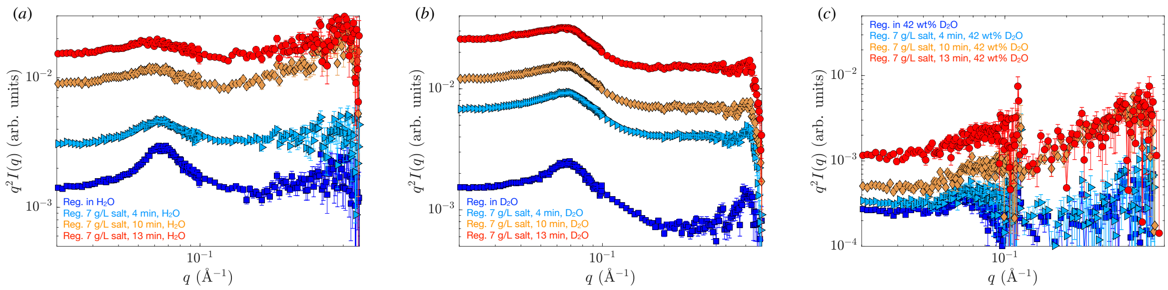

Figure 1 SANS intensity, I(q), as a function of the scattering vector, q, of the regular pasta at different cooking times: raw (squares), 7 minutes (triangles), 10 minutes (diamonds), and 13 minutes (circles). The solvent for the samples are pure H_2O (a), pure $D\$\_2\$O$ (b), and a 58/42 mixture of H_2O/D_2O (c). Data are shifted in the y-direction for clarity.

Based on the data in figure and the corresponding data collected for gluten free pasta we are currently writing a manuscript which also include SAXS measurements performed at Diamond.