INDUSTRIAL PILOT PROJECT

Determination of starch gelatinization and polysaccharide gelation using SAXS and WAXS for optimized product quality

THE INDUSTRIAL CHALLENGE

Lantmännen is a large producer of polysaccharides, especially starch and flour for the baking industry. Polysaccharides are important in foods as thickeners, stabilizers, food matrix and texturizers. During heating, starch granules start to take up water and swell. The water uptake and swelling result in gelatinization of the granule, which is influenced by the internal granule structure. To optimize their products Lantmännen has a large interest to establish new knowledge about how polysaccharides interact with water and to learn about gelatinization and gelation mechanisms.

WHY USING A LARGE SCALE FACILITY

Monitoring a polysaccharide sample in situ during heating would be optimal for determining the structure changes at both the nanometer and Ångström level. This could be probed by small angle and wide angle X-ray scattering (SAXS/WAXS), respectively. WAXS provides information about how individual molecules are organising themselves and it is especially sensitive to the crystalline structure, while SAXS reveals the ordering of assemblies at longer length-scales (tenths of nanometers). However, to follow a process that takes place in a short period, the high photon flux of a synchrotron radiation source is of necessity. It enables high signal-to-noise ratio and fast time-resolved measurements which are essential to determine time-dependent detailed structure changes at different conditions.

HOW THE WORK WAS DONE

The SAXS/WAXS experiments were performed at beamline 16 at the Australian synchrotron at ANSTO in Melbourne, see Figure 1. The effect of temperature, gluten, flour type, and storage on the starch gelatinization were investigated, using a heating and cooling stage for capillaries. Samples with 60 wt% water and 40 wt% flour were prepared and put into capillaries. B. Mansel, National Tsing Hua Univ., M.A.K. Williams, Massey Univ., T. Ryan, ANSTO, L. Lundin, CSIRO and A. Leis, Univ. Melbourne are acknowledged for support during the SAXS/WAXS measurements.

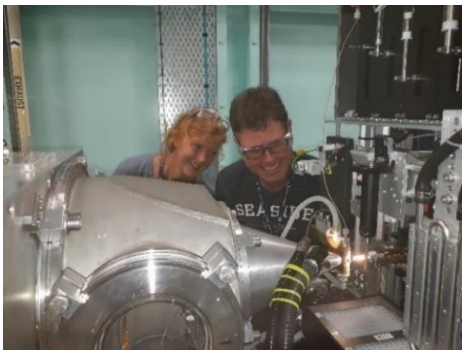

Figure 1. Annika Altskär and Niklas Lorén, RISE, mounting samples at Beamline 16, ANSTO

THE RESULTS AND EXPECTED IMPACT

The results showed that the temperature influences the crystallinity of the starch (see Figure 2) and that gluten and flour type influence the start and kinetics of the starch gelatinization. The project has resulted in a research project on swelling of A- and B-starch, water distribution and bread quality funded by their research foundation. In that project, SAXS/WAXS analyzes will be combined with microscopy, DSC and sensory analysis. This will increase Lantmännen's opportunities to tailor flour of different quality to its customers.

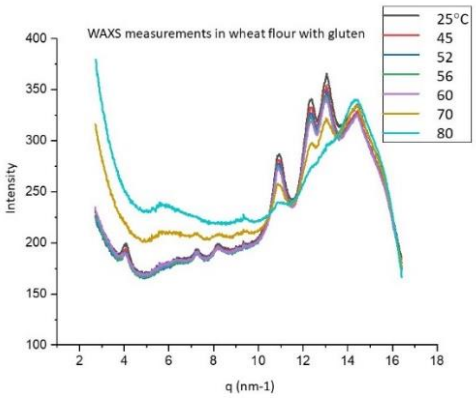

Figure 2. WAXS measurements showing loss of order (i.e. crystallinity) of starch granules during heating. q = $2\pi/\lambda$, where λ is a length-scale in the structure.

Contacts: Christian Malmberg – Lantmännen Central Research, christian.malmberg@lantmannen.com
Niklas Lorén – RISE Agriculture and Food, niklas.loren@ri.se
Shun Yu – RISE, shun.yu@ri.se

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