LSI SUPPORT FOR PhD-STUDENTS IN APPLIED AREAS

Synchrotron X-ray scattering reveals the multiscale assembly of dietary fibre gels derived from cereal side streams

THE PURPOSE OF THE PHD PROJECT

Cereal bran is the outer layer that surrounds the grain endosperm and represents a valuable biomass resource that is rich in dietary fibre polysaccharides and can be used for advanced nutritional and material applications. Specifically, wheat bran constitutes the main by-product from the wheat milling process, accounting for approximately 300,000 tonnes yearly in Sweden. Bran is currently almost exclusively used as animal feed, due to the poor organoleptic and nutritional value of this fraction for human consumption. In the framework of a PhD student project together with Lantmännen, we aim to develop multifunctional bio-based films and hydrogels using dietary fibre polysaccharides extracted from cereal brans that can be used for advanced food and biomedical applications.

We have recently developed a process for production of food hydrogels through enzymatic crosslinking of feruloylated arabinoxylan, which is the main dietary fibre component in cereal brans. These hydrogels show remarkable rheological properties and stability, especially in acidic conditions, together with bioactive properties such as antioxidant and prebiotic. These gels show promising potential for applications as healthy food ingredients, which is of extreme interest for the industrial partner. However, the multiscale structure from the nano- to the macro-level and the mechanisms for gel formation upon enzymatic crosslinking are not understood.

USING A LARGE SCALE INFRASTRUCTURE

The use of synchrotron wide-angle X-ray scattering (WAXS) and small-angle X-ray scattering (SAXS) is required to characterize the multiscale assembly of the dietary fibre networks from the molecular to the gel microstructure levels.

In the project we have used access to WAXS/SAXS infrastructure at the MAX IV Laboratory in Lund (Sweden) through the CoSAXS line. The CoSAXS beamline was able to provide the required experimental conditions, i.e. photon flux and broad q-range to cover the relevant length scales of the cereal dietary fibre hydrogels.

RESULTS AND IMPACT

The use of synchrotron X-ray scattering techniques has enabled us to understand the multiscale network structure of the cereal hydrogels, from the formation of ordered regions at the polymeric level up to their aggregation into supramolecular clusters. Moreover, the results have shown that both chemical (e.g. covalent crosslinks) and physical phenomena (e.g. hydrogen bonding) drive gel formation.

The results of this project contribute to fundamental understanding of cereal dietary fibre gelation and led to the design of innovative multifunctional hydrogels. This opens new possibilities to adjust the conditions and finetune the properties of such cereal gel hydrogels according towards the targeted application. This project also contributes to Lantmännen's efforts in green energy and materials by valorizing underutilized side streams of their processes for novel applications.

The results provided by the project resulted in several scientific articles included in the PhD thesis of the student Secil Yilmaz Turan, who successfully defended the thesis at KTH on 2021-11-04. Moreover, the project has resulted in the establishment of new collaborations between KTH and MAX IV Laboratory included in the program Nordic Lights on Food.

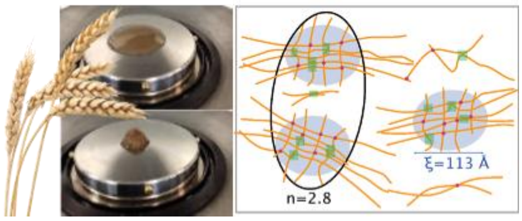

Figure. Multiscale assembly of hydrogels via enzymatic crosslinking of cereal dietary fibres

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