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HIERARCHICAL ARCHITECTURE OF CELLULOSE AND ITS INTERACTION WITH OTHER PLANT CELL WALL POLYSACCHARIDES

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Plant cell walls (PCWs) are extremely complex structures in which cellulose microfibrils are hierarchically assembled and embedded in a multi-component matrix. While the cellulose microfibrils represent the basic building unit providing mechanical strength [1], the matrix components are able to tune the properties of each specific tissue [2-3], increasing the flexibility or limiting the transport of moisture, for instance.

The synthesis of cellulose hydrogels by means of bacterial fermentation is an efficient approach to mimic the cell wall biosynthesis process and investigate the interactions established between cellulose and matrix polysaccharides by incorporating the latter into the culture medium. We have characterised cellulose hydrogels and their composites with PCW polysaccharides by means of SANS and SAXS, combined with complementary techniques such as X-ray diffraction, spectroscopy and microscopy. Furthermore, the production of partially deuterated cellulose hydrogels by using a deuterated glucose-based feedstock is presented as a strategy to enhance the neutron scattering length density contrast [4].

The application of a multi-technique characterisation approach enabled elucidation of the complex hierarchical architecture of cellulose hydrogels and led to the development of a multi-scale model based on core-shell structures [4-8]. The model describes the multi-phase structure of cellulose microfibrils and ribbons, as well as the essential role of water at the different structural levels. In addition, USANS experiments are presented as a promising method to characterise the structure of native cellulose in the longitudinal direction, providing information on the microfibril length and ribbon twisting periodicity.

PCW polysaccharides such as xyloglucan, arabinoxylan, mixed linkage glucans and pectins during cellulose synthesis have a distinct structural role and interaction mechanism with cellulose (interfering with the crystallisation process and strongly interacting with the cellulose microfibrils, or establishing interactions at the ribbons' surface level).

These results highlight the ability of small angle scattering techniques to provide valuable insights on cellulose biosynthesis and interactions with PCW polysaccharides.

Topic

Biology

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