# Enzymatic degradation of biomass: a porous media approach

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In the present era marked by the desire to build a bio-economy, plant biomass has a vast potential as a source of renewable and environmentally friendly molecules of interest. Deconstruction of biomass by a cocktail of enzymes is relevant at an industrial scale. However, achieving a better understanding of the intimate relationship between synergistic enzymatic activity and deconstruction of mechanisms of enzymatic degradation of such a complex, multiscale porous material is still needed.

In this work, we present some results regarding enzymatic degradation of a model biomass, raw wheat straw, obtained with experimental approaches such as X-Ray tomography or breakthrough curve analysis, which are usually dedicated to more “conventional” porous media.

First, we will present some results obtained using a laboratory-scale X-ray tomograph. Fully hydrated wheat straw samples, placed in a home-made 3D-printed thermostatically controlled bioreactor, are subjected to action of a commercial enzymatic cocktail. Enzymatic activity is monitored using state of the art techniques in enzymology. In spite of a rather limited spatial resolution (voxel size is 1.25 µm), 3D X-ray tomography allows to highlight the selective effects of the enzymatic degradation. Notably, the disappearance of cellulose-rich cell walls as a function of the duration of the enzymatic attack, can be quantified over the full scale of the wheat straw sample (i.e. a few mm in length) offering 3D pieces of information on the degradation process, which contrasts with the 2D picture classically obtained from 2D imaging techniques.

Second, in order to probe the effects of the enzymatic degradation at a sub-micron scale, we analyse breakthrough curves obtained by 2D X-ray radiography, when flushing with pure water a wheat straw initially saturated with a radio-opaque molecular tracer. Experiments are conducted with untreated and degraded wheat straws. Breakthrough curve analysis is used to detect any differences between these two kinds of samples, which traduce an alteration of the transport properties of the tracer within the wheat straw. Modelling of the transport properties (e.g. through an effective diffusion coefficient) in relation with the enzymatic degradation mechanism (e.g. progressive disentangling of the polymer network constitutive of the plan cell walls, prior to its disappearance as imaged on 3D images) is a key point and preliminary results will be presented.

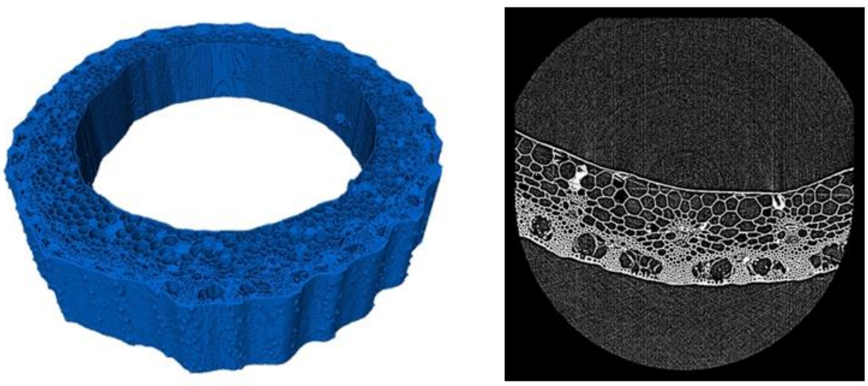

**Figure 1**: 3D rendering of a raw wheat straw from X-ray computed microtomography (left) and a transversal slice for details (right). The external diameter of the wheat straw is 4 mm. Only a portion of the 3D field of view is shown on the left.