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Big pixels can be beautiful too… MALDI MSI sheds new light on plant cell walls

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Cell walls of terrestrial and marine plants are mostly composed of carbohydrates, which form a major reservoir of renewable carbon and a natural source of chemically diverse structures, with varied properties of interest to many industries. Consequently, this biomass is receiving increasing attention in the context of ecological transition. However, the chemical structures of plant carbohydrates remain insufficiently characterized, which impedes their optimal exploitation as well as the understanding of their biological functions. This deficit in structural knowledge is due in part to the lack of analytical methods adapted to the complexity and heterogeneity of these biopolymers. Tackling this analytical challenge with mass spectrometry has been the main objective of our team for over 15 years.

In my presentation, I will show how MALDI mass spectrometry imaging (MALDI MSI) fits into the arsenal of methods we are developing to unveil the structure-function relationship of plant carbohydrates. The wealth of structural information obtained without preconceived ideas is a major asset of MALDI MSI, which attractively complements the alternative methods that can be deployed for plant imaging. The spatial resolution of the technique is well suited to a whole-tissue view, and enables acquisitions in a timeframe compatible with the screening of multiple conditions.

I will show precisely how MALDI MSI, complementing magnetic resonance imaging (MRI), enabled us to establish a correlation between distribution of water and of specific structural features of hemicelluloses in the wheat endosperm. These results shed unprecedented light on the interplay between these major actors of the cell walls, demonstrated for the first time in planta[1-3]. Another example will show how we use MALDI MSI, in correlation with MRI but also with atomic force microscopy (AFM), to tackle the problem of biomass recalcitrance to conversion. In these studies, direct monitoring of tissue degradation can be performed by MALDI MSI and be correlated with morphological and mechanical information at the same location [4]. Our expectation is that we will find new indicators of recalcitrance that can facilitate the selection of appropriate biomass for efficient bioconversion.

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