04-07: Understanding the formation of highly durable heartwood in larch by use of Synchrotron infrared imaging and multivariate resolution techniques

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The formation of highly durable wood tissue (heartwood) is linked to the occurrence of non-structural substances called extractives, which play an important role in the resistance of wood to fungal decay. However, the exact formation and distribution of these extractives within the xylem tissue at the cell and cell wall level is one of the unsolved questions in plant science [1].

Larch heartwood contains extractives and is an important European resource for highly durable wood [1]. The extractives in larch belong to the molecular families of terpenoids, flavonoids, lignans, fats/fatty acids and galactans [2,3]. Very little is known about the deposition and cellular level distribution of larch extractives. The limited knowledge is mostly due to the low relative proportions of extractives in wood, which implies that they easily can be overshadowed by the presence of structural polymers like lignin, which is an aromatic biopolymer.

The objective of this work is to obtain a detailed overview of the heartwood formation process in larch at the microscale level by combining Synchrotron infrared imaging and advanced chemometric tools. The long term goal of this work is to facilitate environmentally benign and bioinspired wood protection systems. Therefore, detailed knowledge is fundamental to the development of biomimicking schemes for impregnation of wood from less durable tree species to replace old hazardous impregnation processes, which are being phased out.

Synchrotron infrared imaging appears to be the ideal technique to study the extractive deposition patterns on the microscale during heartwood formation in larch due to the high brightness and high collimation of the beam, which result in images with high spatial resolution, and the avoidance of fluorescence problems when other high spatial resolution techniques, such as Raman imaging, are used. The use of advanced chemometric tools like Multivariate Curve Resolution Alternating Least Squares (MCR-ALS) has already been proven to adapt particularly well to hyperspectral image analysis due to the ease of the introduction of external spectral and spatial information about the image and the ability to work with single and multiset (several images) image structures [4,5]. Using this approach, we expect to be able to identify the extractives and their deposition pattern at a cell level, including the distinction between cell lumen and cell wall contents. In this way the evolution of heartwood formation in larch will be described both from a spectral and a spatial point of view.

References

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