

# Azo-Dye Formation in Wood: Reactivity of Inherent Wood Polymer Lignin with Diazonium Salts for Tracking

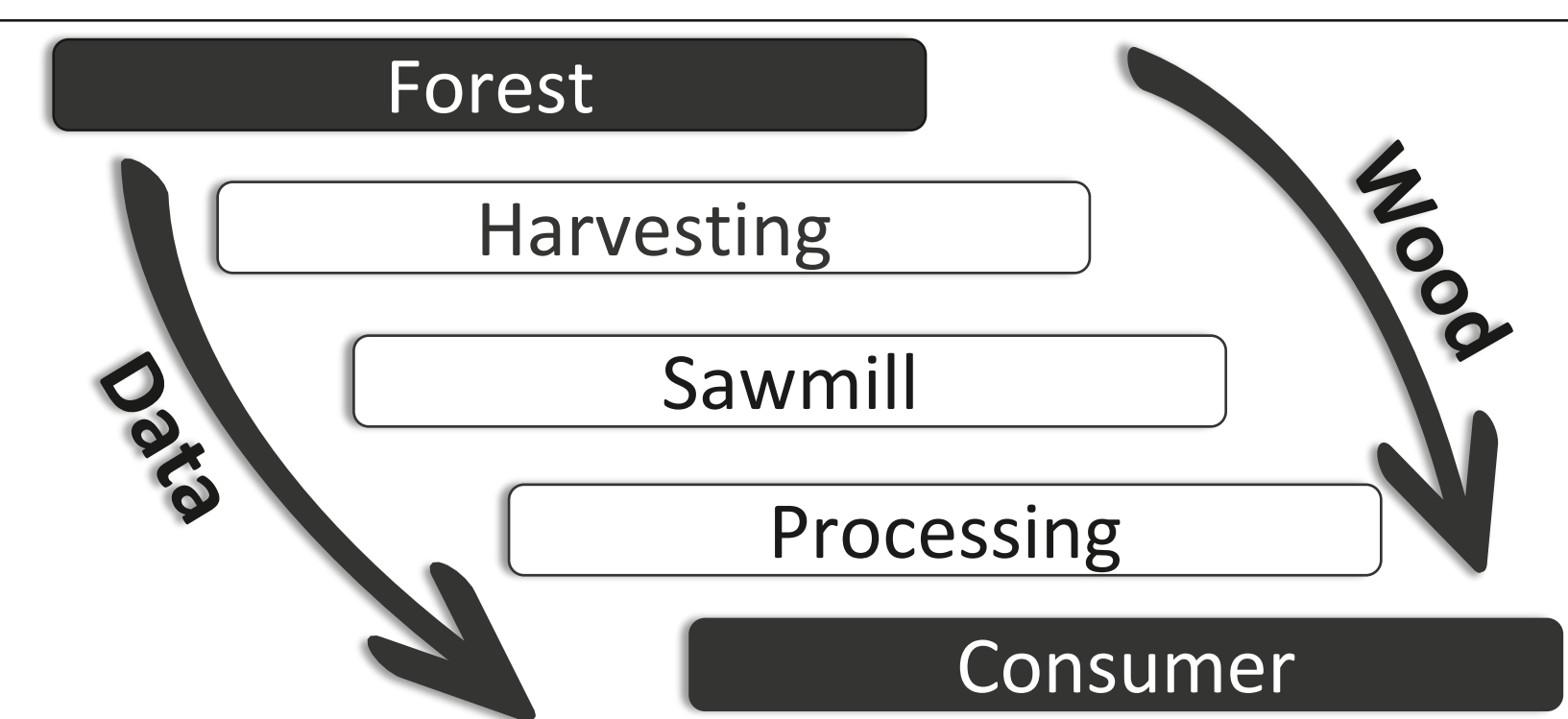
Susanna Ortlieb, Avinash P. Manian, Thomas Bechtold, Tung Pham

Research Institute of Textile Chemistry and Textile Physics, Hoechststrasse 73, 6850 Dornbirn, Austria

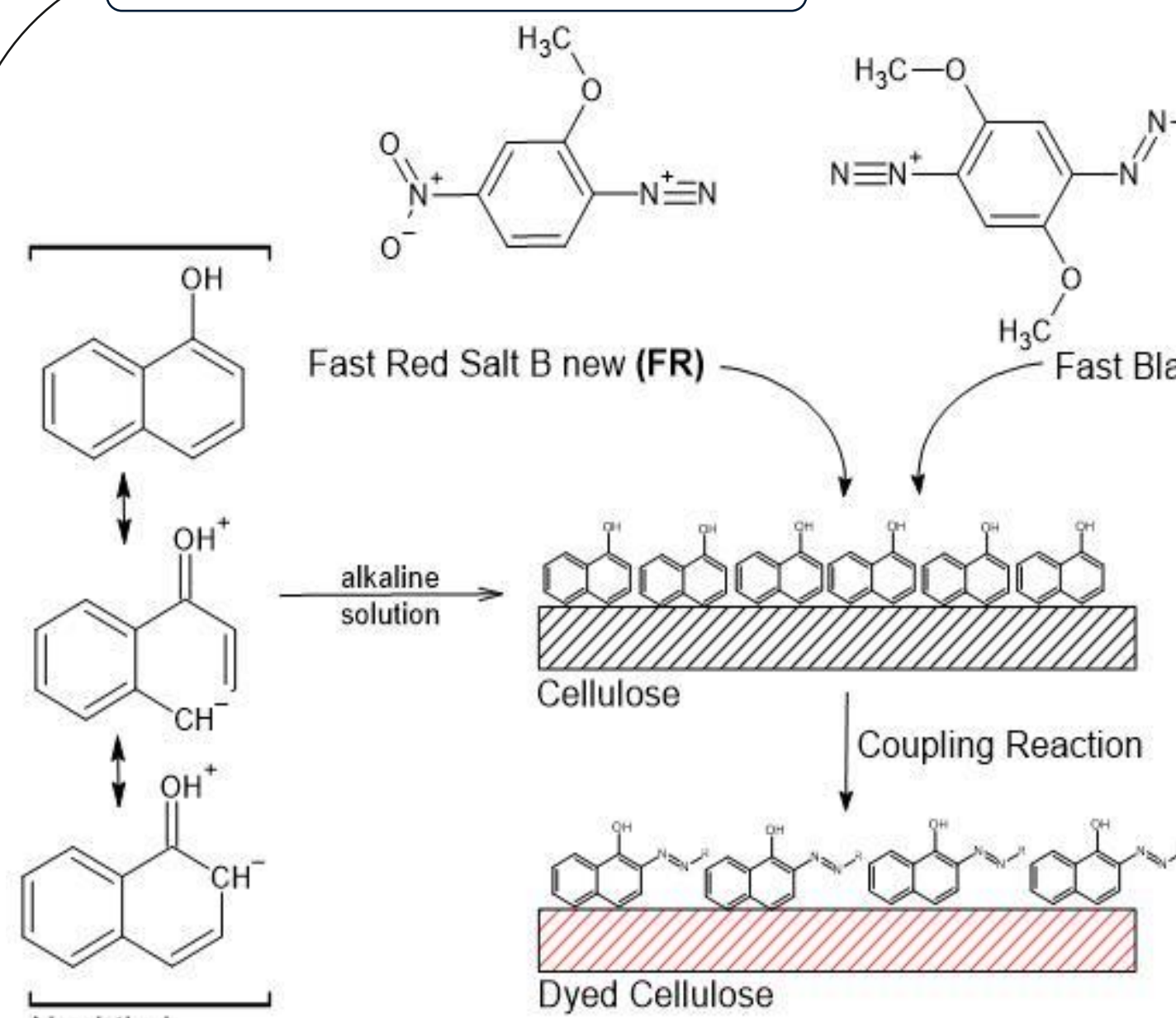
✉ [susanna.ortlieb@uibk.ac.at](mailto:susanna.ortlieb@uibk.ac.at)

## Trace wood project

The EU's Regulation on deforestation-free products from 2023 aims to ensure that products consumed in the EU do not contribute to global deforestation, including those from the wood industry. Consequently, wood tracking, which involves systematic monitoring and documentation of wood throughout the supply chain, becomes critical. Our research focuses on identifying and evaluating suitable marking technologies for a seamless, tamper-proof, and clear identification wood tracking system.

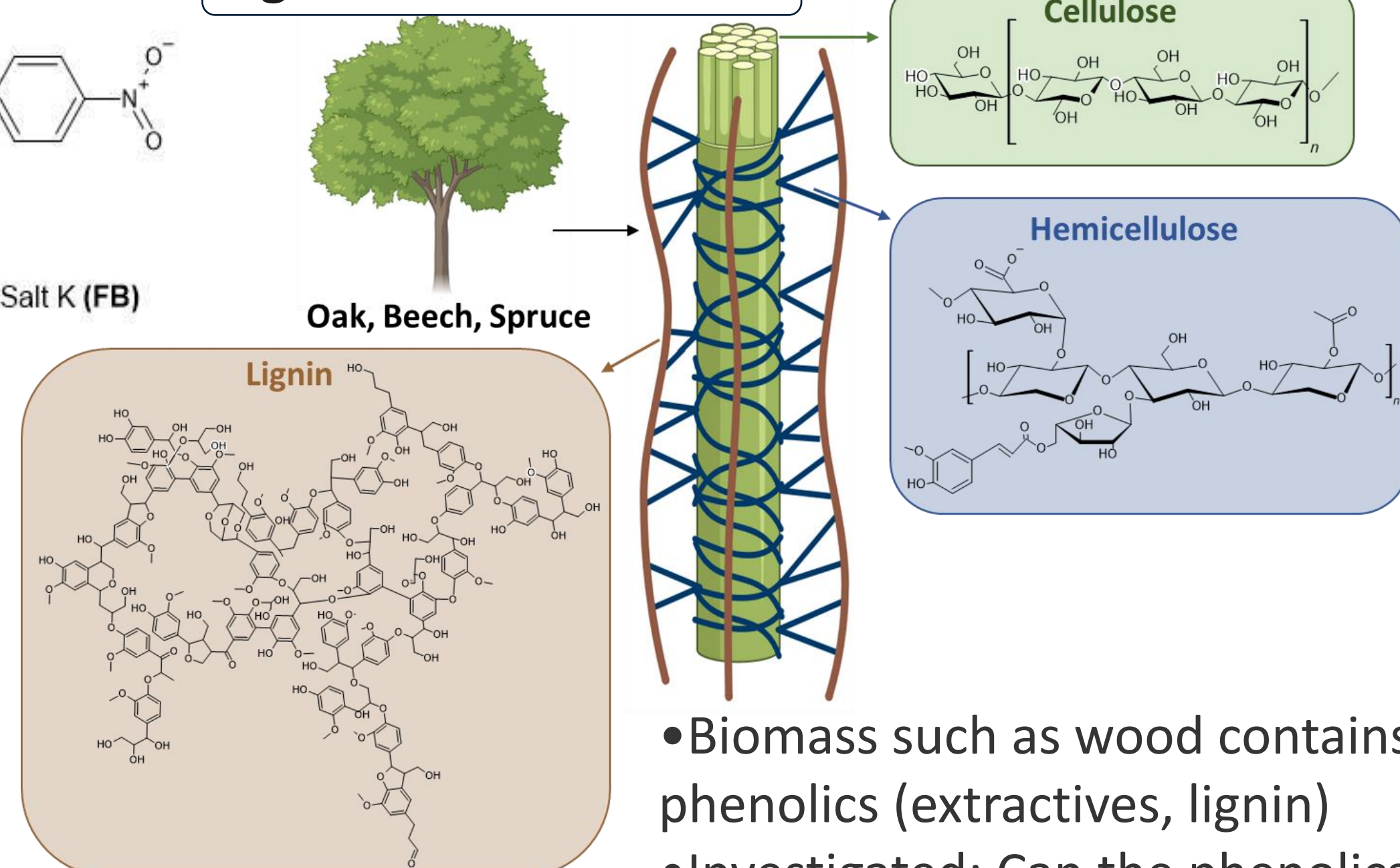


## Development Dyeing



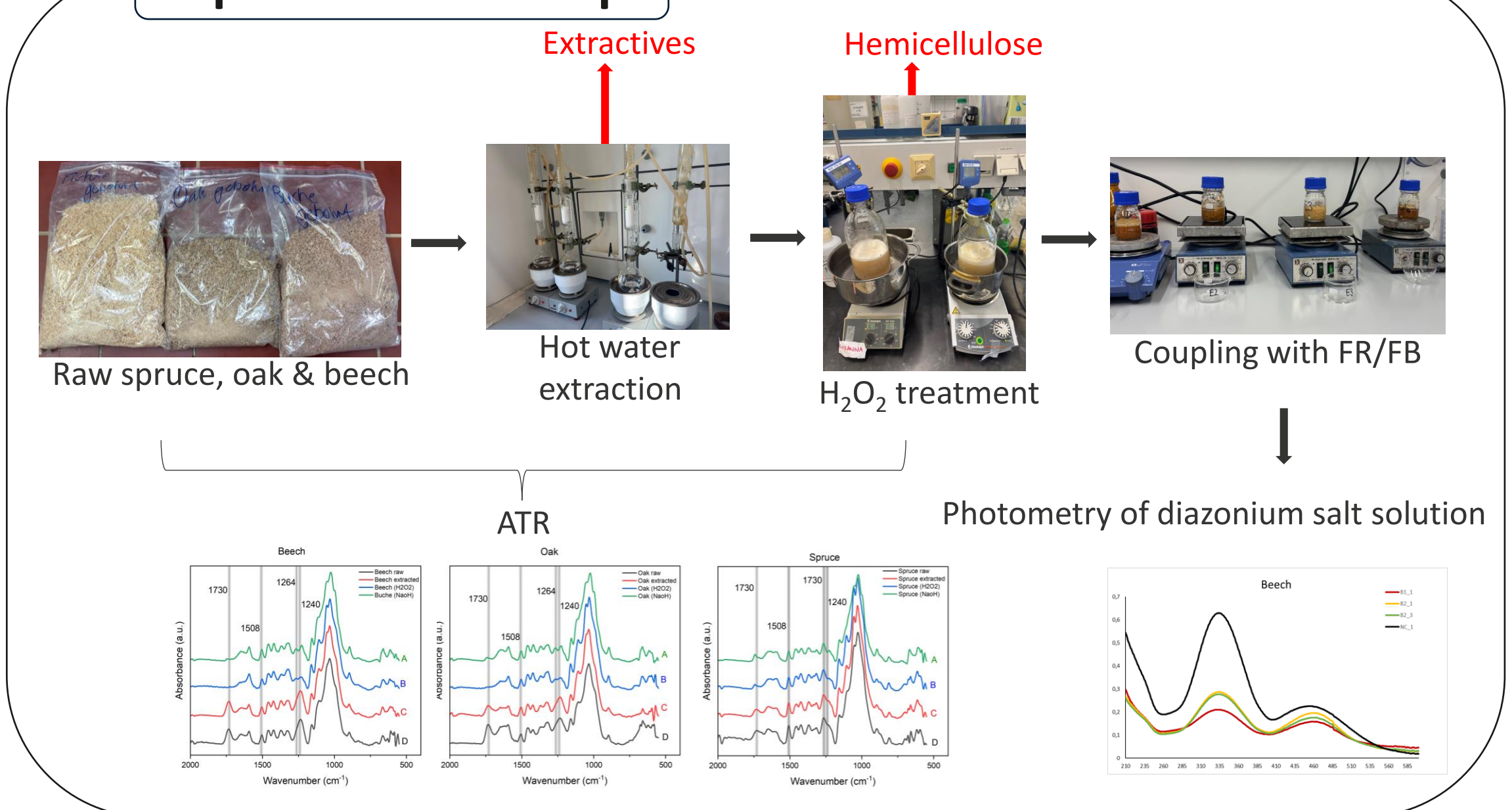
- Textile impregnated with phenolic (e.g., naphthol)
- Naphthol coupled with diazonium salt (electrophilic substitution).
- Yields bright, vivid shades of high wash and light fastness

## Lignocellulose Structure

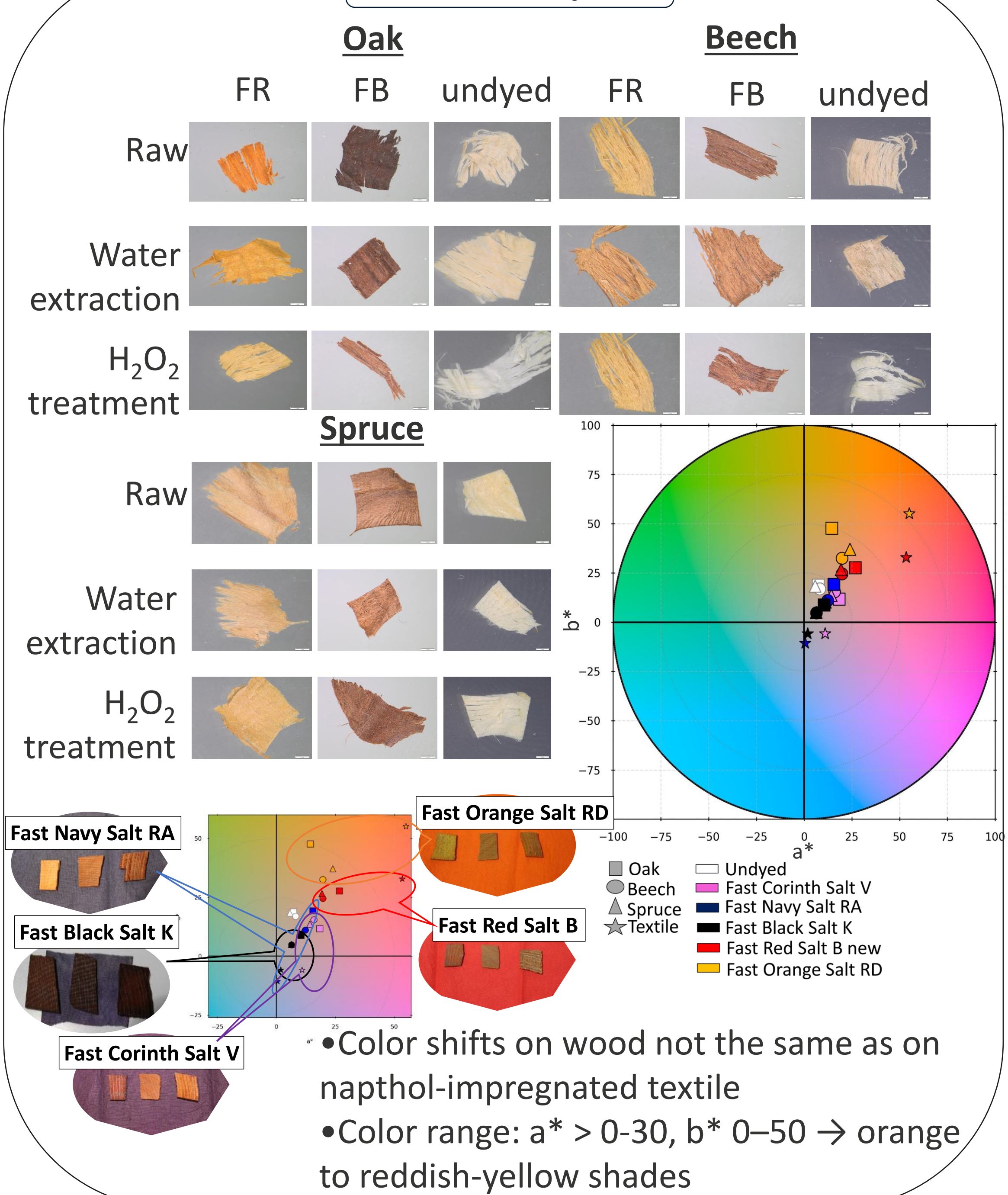


- Biomass such as wood contains phenolics (extractives, lignin)
- Investigated: Can the phenolics in wood couple with diazonium salts to yield detectable color?

## Experimental set-up

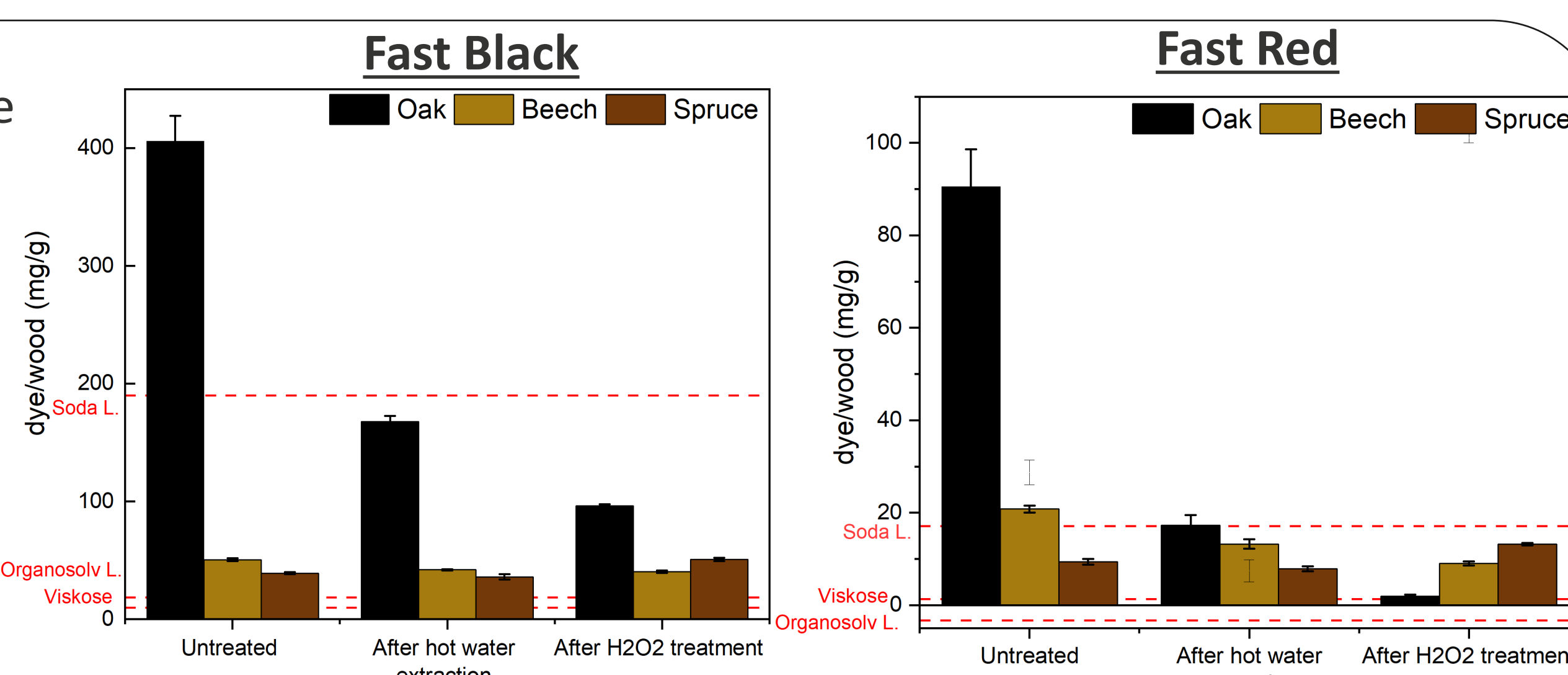


## Colour development



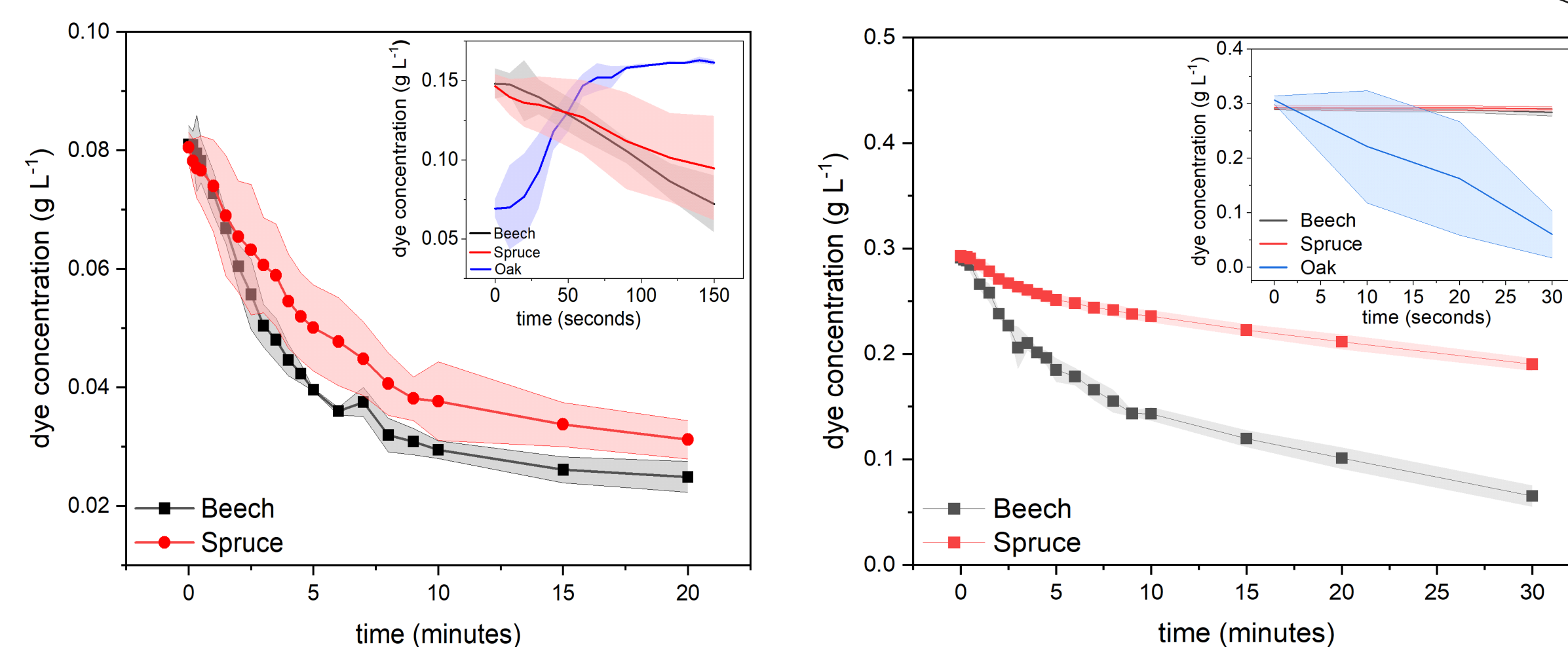
## Dyeing

- Less coupling after extractive removal
- $H_2O_2$  treatment = similar coupling level as untreated
- Cellulose alone: low reactivity
- Soda L. Reactivity > organosolv L.
- Reactivity varies by wood type (density, lignin)

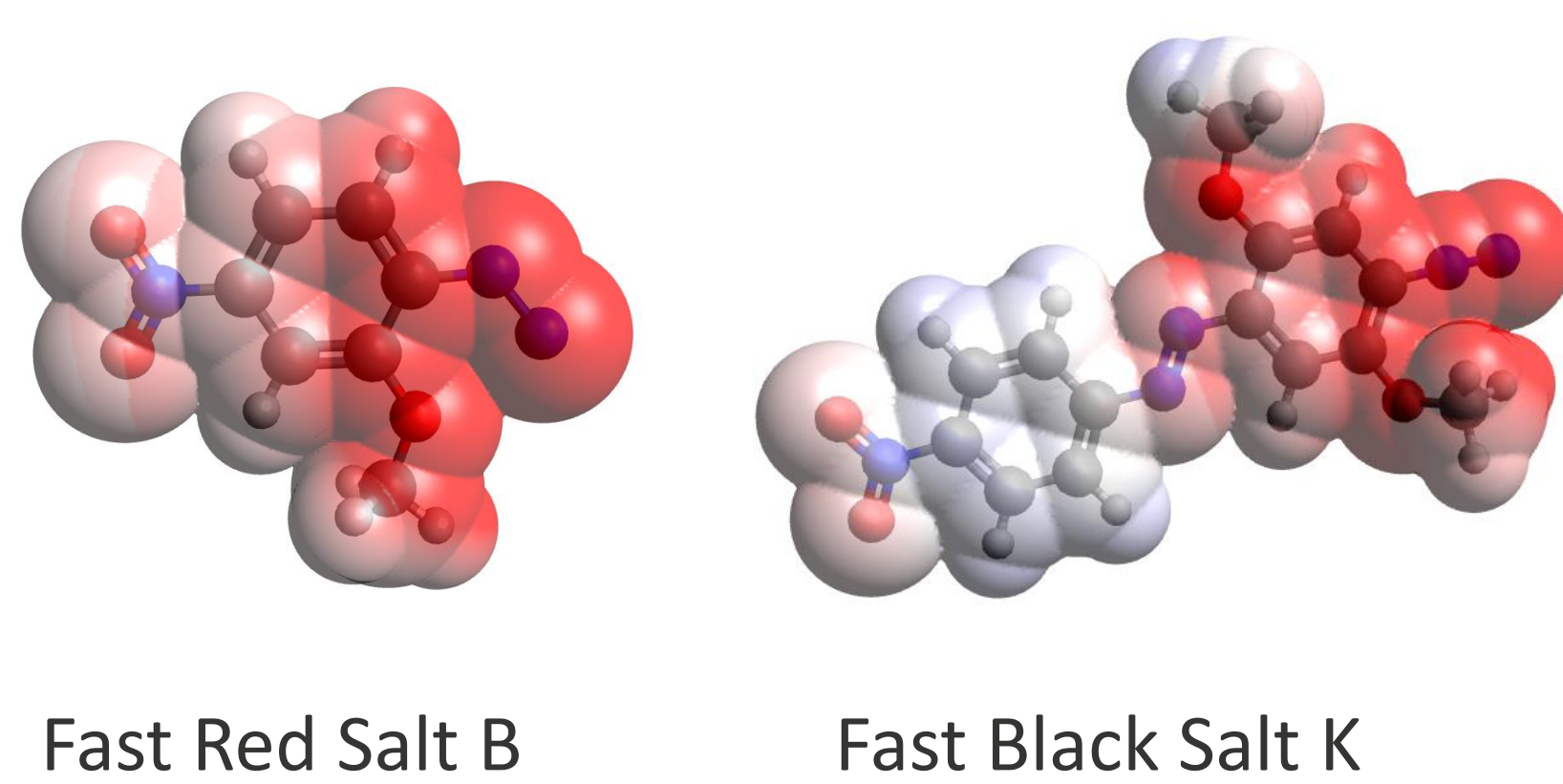


## Kinetics

- Wood type (density, lignin type) affects reaction rate
- Kinetic analysis not possible on oak due to interference from extractives



## Influence of Diazonium salts



Feature	Fast Red B	Fast Black K
Aromatic System	Simple ring	Extended conjugation
Hydrophobicity	Moderate	High
Counterion	Sulfonate (polar)	ZnCl <sub>2</sub> (less polar)
Planarity	Limited	High
$\pi$ - $\pi$ Interactions	Weak	Strong

## Conclusion and Outlook

- Diazonium salts react with phenolic groups of lignin and extractives, causing color change
- Reaction influenced by wood density, lignin type and type of diazonium salt
- Fast Black K shows superior lignin reactivity attributed to extended  $\pi$ -conjugation, dual methoxy activation, higher hydrophobicity, and favorable counterion effects ( $Zn^{2+}$ ).
- Enhanced planarity and  $\pi$ - $\pi$  stacking enable stronger, more selective lignin binding than Fast Red B.
- Outlook: Evaluation of diazonium salts for lignin detection

## References

- Hückel, M. (2008). Recent Developments in the Application of Azoic Dyes. *Journal of The Society of Dyers and Colourists*, 74, 640–646. <https://doi.org/10.1111/J.1478-4408.1958.TB02286.X>
- Qian, H., Hou, Q., Hong, L., Lu, X., Ziegler-Devin, I., Chruscil, L., Besserer, A., & Brosse, N. (2022). Effect of highly efficient steam explosion treatment on beech, poplar and spruce solid wood physicochemical and permeable performances. *Industrial Crops and Products*. <https://doi.org/10.1016/j.indcrop.2022.114901>
- <https://www.trace-wood.at/>

## Acknowledgement

We gratefully acknowledge the Forest Fund of the Federal Ministry of Agriculture for funding this project, and the Think.Wood program of the Austrian Wood Initiative for their support.

