

# Monitoring uptake and penetration of pesticide during impregnation of an impregnable (*Pinus sylvestris*) and a refractory (*Picea abies*) wood species with bio-based emulsion gel formulations



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## INTRODUCTION

Even in dry state, wood is a biologically degradable material. In the absence of protection treatment, wood becomes susceptible to degradation by a variety of natural causes such as wood-rotting fungi, insects including termites. Treatments are a prerequisite to achieve adequate performance and durability of industrial wood. The effectiveness of the preservation treatments depends on the capacity of impregnation of the wood structure, on the technology implemented to incorporate the active ingredients, and on the type of formulation.

The aim was to evaluate a new generation of bio-based emulsion gel industrial formulations. The impregnability of two coniferous species commonly used in construction and other applications, the easily impregnable pine (*Pinus sylvestris*), and the refractory spruce (*Picea abies*), was assessed after treatment with those bio-based formulations, and the extent of penetration and retention of the active ingredients were quantified by series of analytical methods.

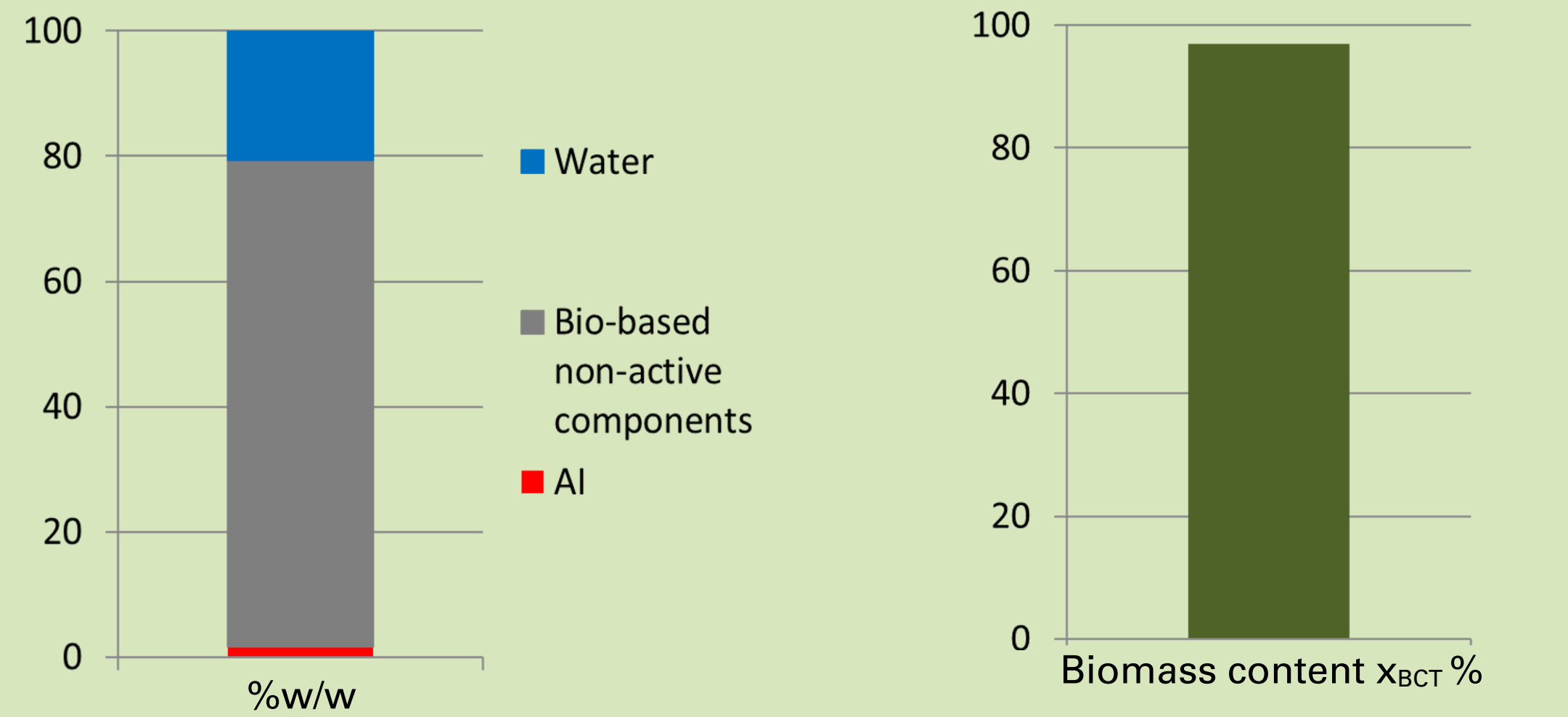
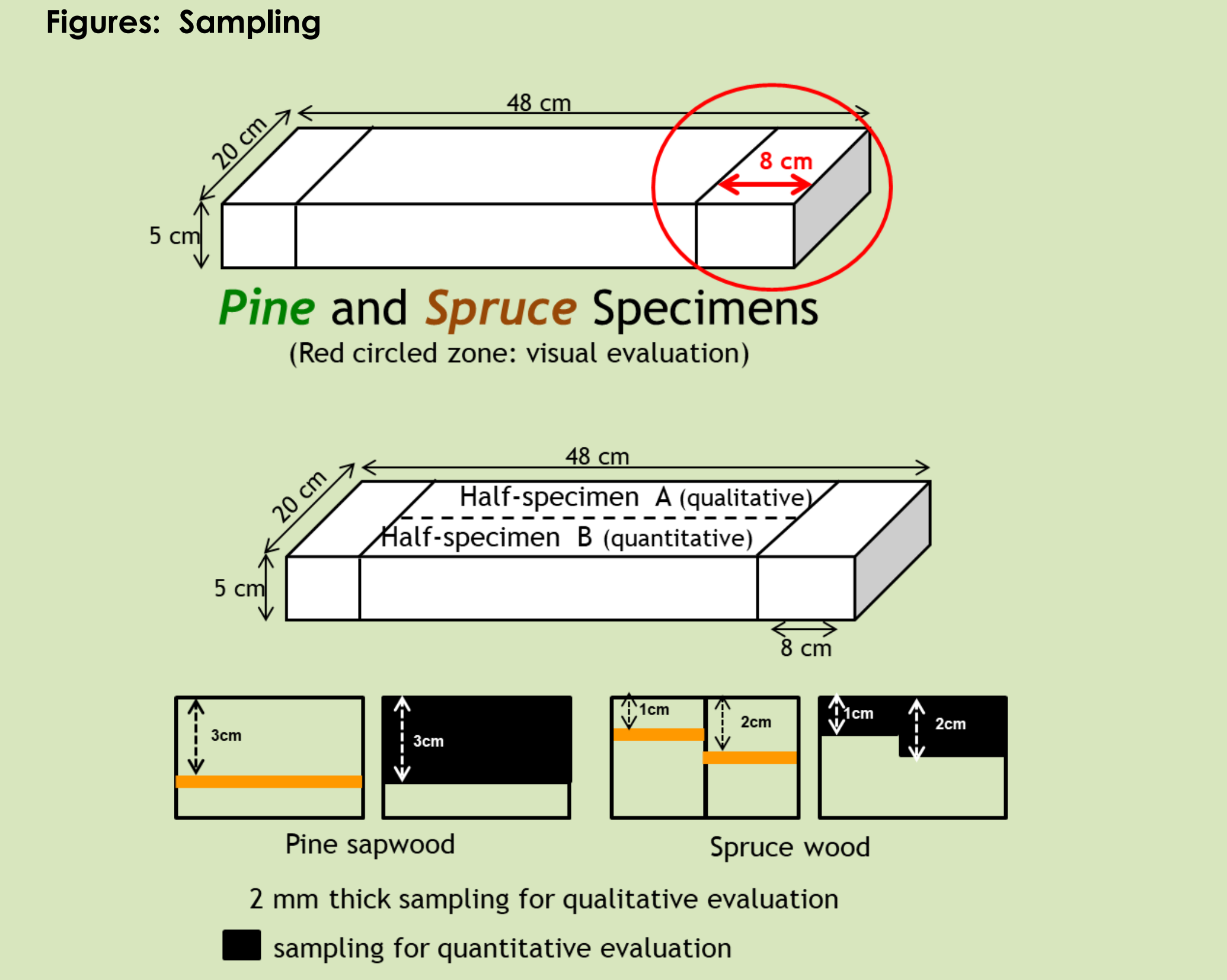
The difference of penetrability between the impregnable and the refractory species, and the effectiveness of this bio-based emulsion gel technology are demonstrated.

## EXPERIMENTAL METHODS

- Test products:**
- Reference: Microemulsion (ME) (propiconazole+tebuconazole+IPBC+cypermethrin)
  - Biobased Gel Emulsion (Lab2021\_006)
    - > 99% bio-based content according to E.U norm NF EN 16640, 2017 and International norm ASTM D 6866,
    - containing bio-based non-active co-formulants (bio-based isoparaffinic co-solvents, bio-based surfactants, cellulose thickener, Plant Polyphenolic Extract from Berkem Biosolutions®) + water + active ingredients AI (tebuconazole + cypermethrin)

**Wood selected for the preservative treatment and testing:**  
 Pine (*Pinus sylvestris*) and Spruce (*Picea abies*) specimens 480 x 200 x 50 mm (longitudinal x radial x tangential), conditioned in a climate chamber at 20°C and 65% relative humidity for 7 days prior to testing

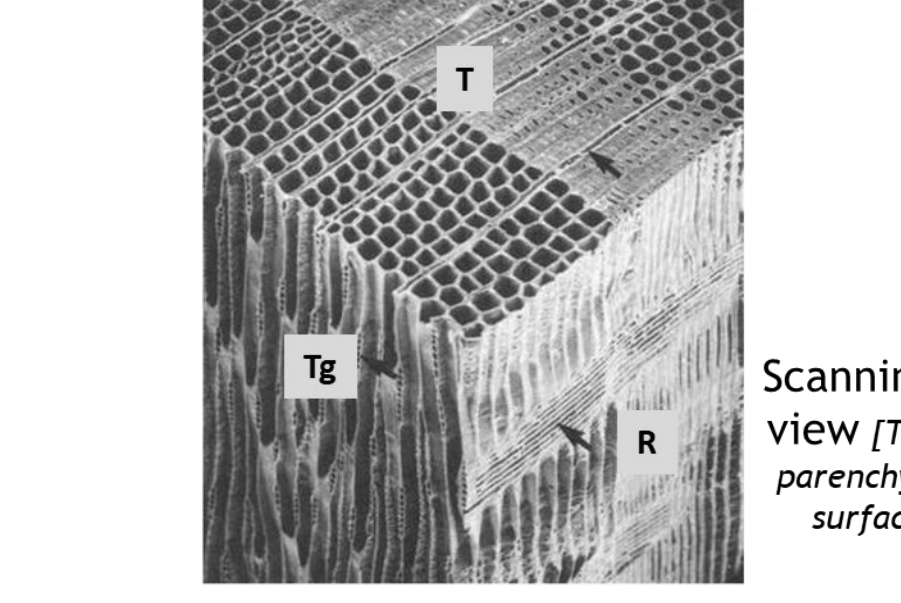
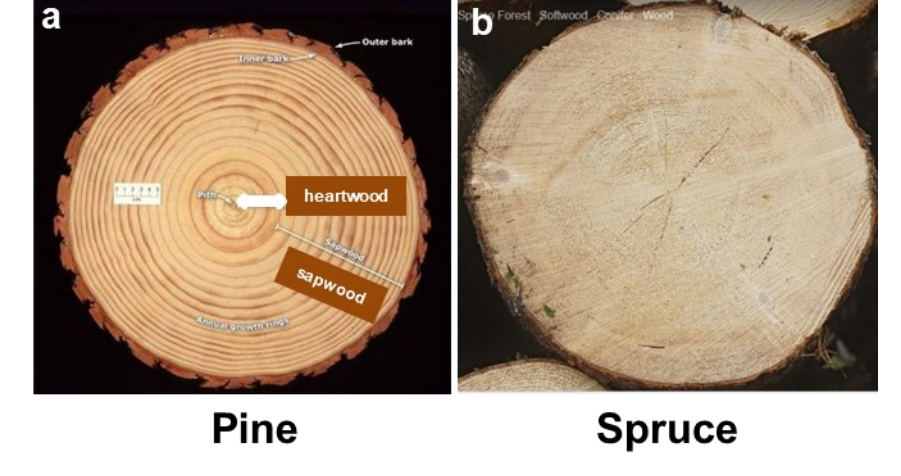
- Assessment of impregnation extent:**
- visual observation of the penetration
  - qualitative and quantitative analysis of penetration and retention of AI performed by weighing and by Gas-liquid Chromatography coupled to Mass Spectrometry (GC/MS)



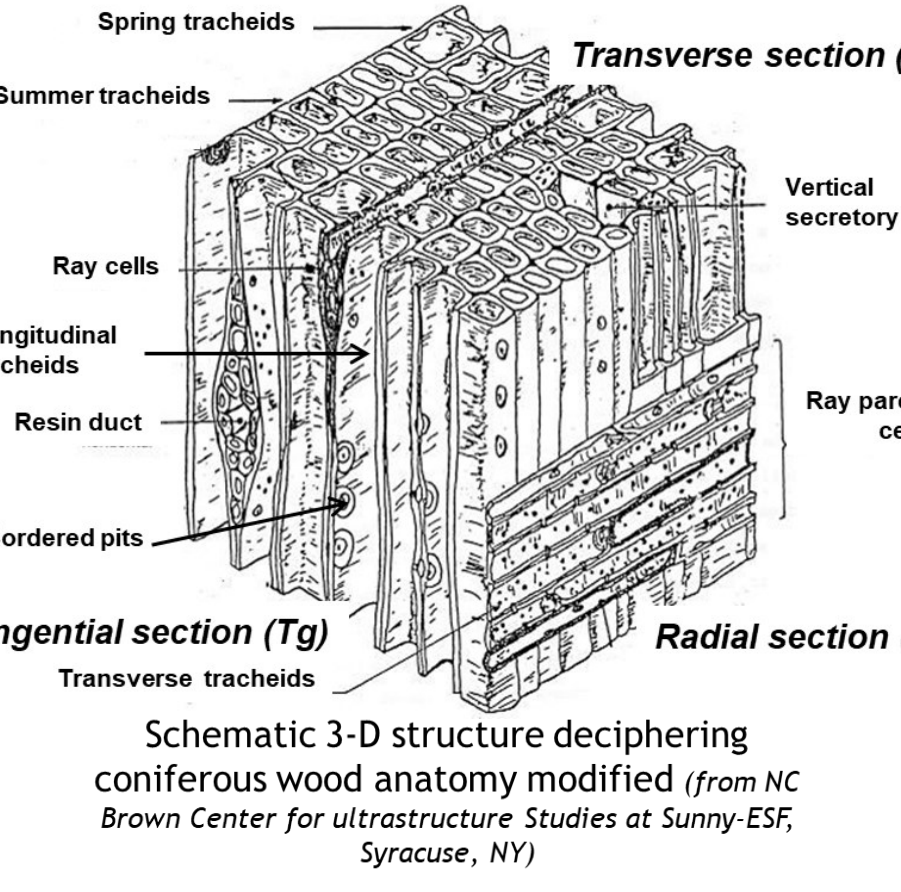
## Analysis of the structural anatomical factors controlling the penetrability of the easily impregnable Pine versus the refractory Spruce wood

### IMPORTANCE OF CONIFEROUS WOOD STRUCTURAL ORGANIZATION IN THE PENETRABILITY OF FORMULATIONS

Cross sections through Pinus and Spruce wood showing the absence of clear differentiation between heartwood and softwood

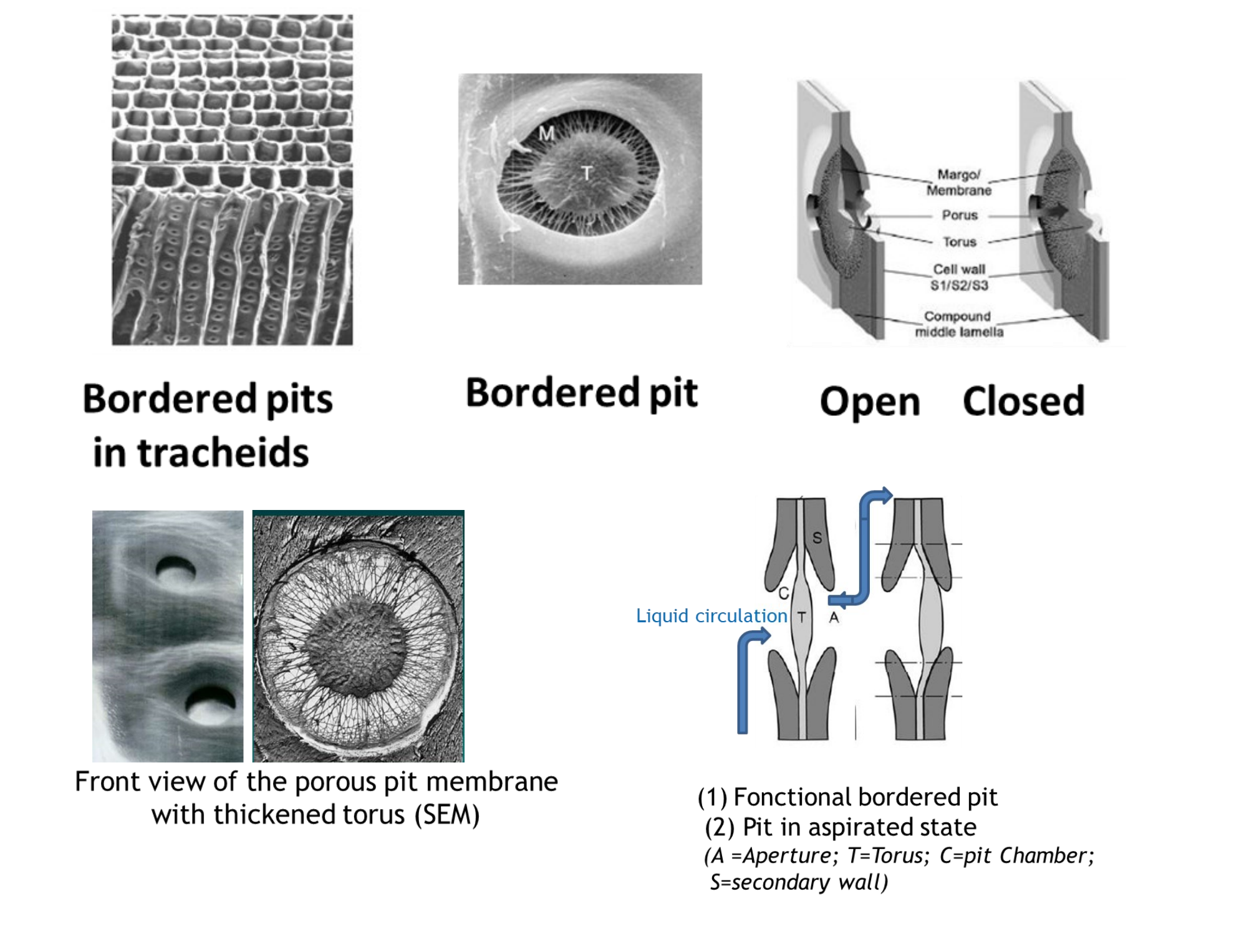
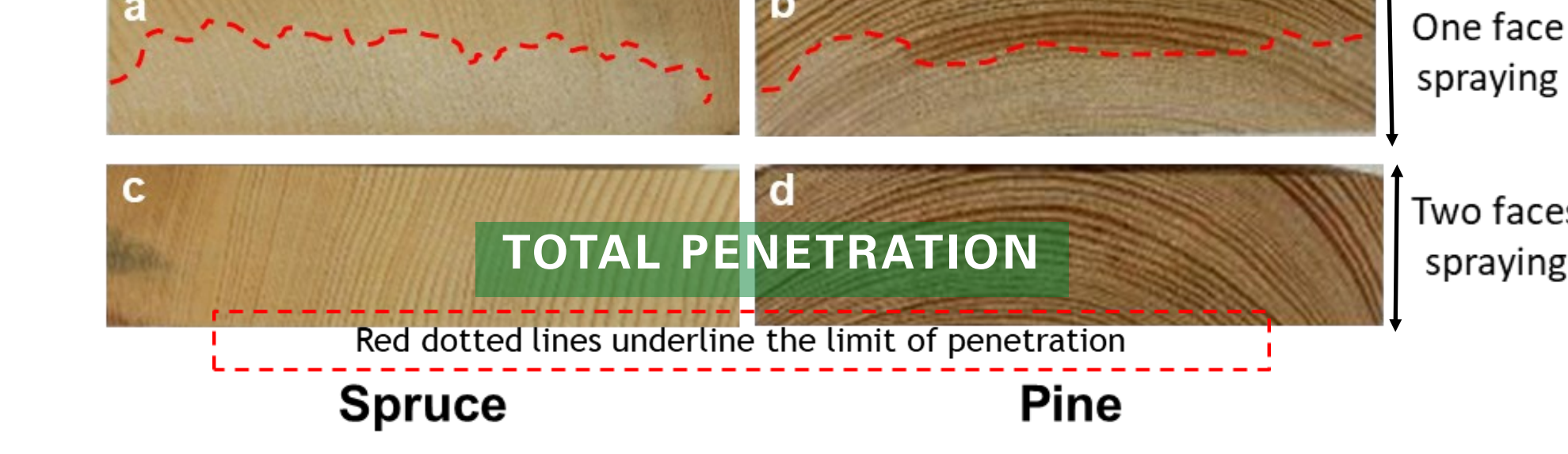


### c General structure of Softwood species



### IMPORTANCE OF BORDERED PITS OPENING IN PENETRATION AND DIFFUSION IN WOOD

#### Diffusion of Biobased gel emulsion Lab2021\_006



## RESULTS

### Quantification of penetration and retention of the active ingredients

**Table: Mean uptake in Pine and Spruce specimens**  
 n=10, 4 weeks  
 High uptake in both wood species. Easily impregnable Pine >> Refractory Spruce

Wood specie / Treatment	Results		
	Distance of sampling from surface	Penetration	Retention (max)
<b>Pine - Lab2021_006</b>	<b>0 to 3cm</b>	<b>&gt; 3 cm</b>	<b>300 g/m<sup>2</sup></b>
Pine / dipping 3min - ME	0 to 6mm	≤ 6 mm	235 g/m <sup>2</sup>
Pine / dipping 15min - ME	0 to 6mm	≤ 6 mm	275 g/m <sup>2</sup>
Pine / vaccum - ME	total	total	650 kg/m <sup>2</sup>
<b>Spruce - Lab2021_006</b>	<b>0 to 2cm</b>	<b>&gt; 2 cm</b>	<b>240 g/m<sup>2</sup></b>
Spruce / dipping 3min - ME	0 to 3mm	≤ 3 mm	130 g/m <sup>2</sup>
Spruce / dipping 15min - ME	0 to 3mm	≤ 3 mm	181 g/m <sup>2</sup>
Spruce / vaccum - ME	total	total	220 kg/m <sup>2</sup>

### Evaluation of efficacy by biological tests

Durability of treated wood by Lab2021\_006 against biological agents (xylophagous fungi, molds, xylophagous insects and termites) for use classes 1 to 3.2 is confirmed by standardized tests as required by the standards NF EN 599 (preventive) and NF EN 14128 (curative).

Number of applications	One face spraying	Two faces spraying
<b>Critical values</b>	<b>300g/m<sup>2</sup></b>	<b>2 x 300 g/m<sup>2</sup></b>
Biological tests	EN46 (+EN73+EN84)	EN117 (+EN73+EN84)
	EN118 (+EN73+EN84)	EN47 (+EN73+EN84)
	EN1390	EN113 (+EN73+EN84)
	EN370+EN73	



## CONCLUSION

Due to its specific composition (strong fixation of active ingredients, >99% biobased composition, Plant Polyphenolic Extract from Berkem Biosolutions®), Lab2021\_006 - the aqueous bio-based gel formulation induced remarkable and improved surface impregnation and diffusion of the active ingredients in both the penetrable and the refractory species, in agreement with its observed biological efficacy.

Lab2021\_006, only by surface application, diffuses in >3cm depth in Pine and >2cm depth in Spruce after 4weeks.

The bio-based emulsion gel technology is a real alternative to conventional water soluble products for vaccum impregnation. The present work highlights the positive role of bio-based emulsion gel industrial formulations and their potential on wood preservation.

Reference : Messaoudi, D, Ruel, K Joseleau, J-P (2020) Uptake of insecticides and fungicides by impregnable and refractory coniferous wood species treated with commercial bio-based emulsion gel formulations. Maderas-Cienc Tecnol 22(4): 505-516

