Natural biocides based on pepper extracts for protection of wood samples: changes in wettability and crystallinity after fungal decay

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Introduction

Pinus sp. is the most common tree species in reforestation lands; but is widely susceptible to sources of chemical deterioration (insects and fungi). Wood-decaying fungi play an important role in the degradation of main components of wood: cellulose, hemicellulose, and lignin. To prevent decay, water-soluble chemicals have been used; but are related to soil and water contaminations. Natural preservatives have been considered harmless for wood treatment such as oil and wax finishes. Here, we are interested in the role of pepper oil extracts as wood preservatives aiming at increasing resistance, durability and surface quality. Two fungi were studied: *Paecilomyces variotii* (soft-rot fungus) (Pae) and *Pycnoporus sanguineus* (white-rot fungus) (Pyc), based on different degradation approaches. We compared changes in wettability, mass loss and crystallinity after treatment with pepper oleoresins.

Results and Discussion

Pinus sp. samples were dried at moisture content of 12% and treated with pepper (capsicum) oleoresin from Malagueta (Mal), Red Savina (RS), and Bhut Jolokia (BJ). *Pae* and *Pyc* fungi were used for inoculation at a culture medium prepared using Sabouraud-dextrose agar. The fungi kept for 16 weeks on the wood samples. Contact angles were measured using water (W), ethylene glycol (EG), formamide (FA), and diiodomethane (DI) before and after treatment with capsicum oleoresin. Figure 1 shows the profile images obtained for liquid drops on *Pinus* sp. The curvatures of the drops have indicated that the contact angle (θ) is higher for the samples treated with oleoresin, in particular BJ. High values of θ indicate a surface hydrophobicity. The oleoresin was able to spread on the wood surface, which became hydrophobic. In different probe liquids, θ increased from W, DI, FO to EG. In water, the values of θ are smaller than 10^{o} that means completely wetted surfaces. The highest values of θ were obtained in EG, from 10^{o} to 68^{o} (treated with BJ), indicating a tuning from hydrophilic to hydrophobic surfaces. The evaluation of the sample durability was performed by measuring the mass loss. Crystallinity percentage was calculated based on the main X-ray peaks of cellulose. Peppers with higher levels of pungency (RS and BJ) yielded better protected samples, with the crystallinity percentage increasing after the surface treatment. Both fungi (*Pae* and *Pyc*) are capable to degrade the samples, but are related to different decay mechanisms and decay rates as indicated in Figure 1.

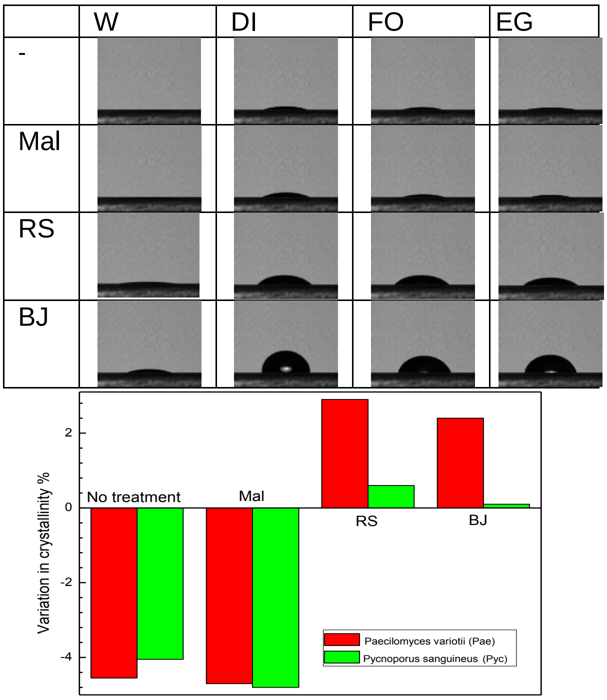

Figura 1. Images of liquid drops on *Pinus* sp. and difference in crystallinity before and after treatment.

Conclusions

Lower values of θ were obtained in water (polar solvent), due to a predominantly hydrophilic surface. The hydrophobicity of *Pinus* sp increased from Malagueta, Red Savina to Bhut Jolokia. Changes in crystallinity were verified for decayed samples, evidencing that pepper oleoresins appoint as an alternative for conventional wood preservatives. Crystallinity played an essential role in the understanding of the chemical changes produced by fungi since it was verified a strong dependence on the surface condition for treated samples.

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