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«THE ROLE OF NITROGEN IN WHITE- BROWN-ROT DECAY: PRESENTATION OF AN ECOLOGICAL MODEL»

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reprint from
Les colloques de l'INRA, Paris 1987
n° 40
LIGNIN ENZYMATIC AND MICROBIAL DEGRADATION
Paris, 23-24 avril 1987

1987

PUBLICATION n° 121

http://forestgeomat.ffg.ulaval.ca/brf/

edited by
Coordination Group on Ramial Wood
Department of Wood and Forestry Science
Québec G1K 7P4
QUÉBEC CANADA

The role of nitrogen in white and brown-rot decay: presentation of an ecological model

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RÉSUMÉ

Un modèle simplifié est présenté dans lequel la limitation en azote dans le bois est considérée comme la principale cause de la dégradation de la lignine par les champignons de la pourriture blanche ainsi que de la modification de la lignine par les champignons de la pourriture brune. Ce modèle s'appuie sur les résultats d'expériences de dégradation au laboratoire et à partir d'échantillons collectés dans la nature qui indiquent que ces champignons sont capables de mobiliser l'azote lié à la lignine par différents mécanismes.

SUMMARY

A simplified model is put up for discussion, in which limited nitrogen availability in wood is regarded as the main cause for degradation of lignin by white-rot fungi as well as for lignin modification by brown-rot fungi. The model is substantiated by results obtained from degradation experiments under laboratory conditions and from collected field samples, both indicating that white- and brown-rot fungi are actually able to mobilize lignin-bound nitrogen, though using different mechanisms.

INTRODUCTION

It is well known that wood contains only small amounts of nitrogen (N). The N concentration seldom exceeds 0,3% of dry weight and usually is in the range of 0,3 to 0,1%. The C/N ratio is extremely high, varying from about 350:1 to 1250:1 (Merrill and Cowling, [1966a]).

In a previous paper (Dill et all [1984]) we showed that the N in wood of different hardwood species consists of hydroxyproline-rich amino compounds and that always about half of it appears in the sulfuric acid-insoluble Klason lignin fraction. We suggested that this N portion is firmly bound to the lignin polymer as in lignoprotein complex. Moreover, Merrill and Cowling [1966b] found that most of the N in wood is resistant to extraction with neutral solvents and proteolytic enzymes. These findings indicate that the already limited N source in wood is not freely available to wood degrading mircoorganisms.

Nevertheless, white- and brown-rot fungi have evolved very efficient mechanisms to degrade this extremely N limited substrate. Their strategies seem to be very different from each other insofar as white-rotters degrade all wood

components while brown-rotters only degrade the polysaccharides leaving behind, as generally assumed, a heaviliy modified lignin.

The question is how these fungi get access to the N sources of wood espacially if they are able to exploit the N portion which is bound to the lignin polymer. It is easy to imagine that white-rot fungi acquire N by degrading the lignin. But have brown-rot fungi really developed a mechanism for merely extracting N from undegraded lignin complexe?

In the case of white-rot, the fungus in our scheme should be basidiomycete of the widespread "N-sensitive type". This means that its ligninolytic activity depends on N concentration in the substrate: increased N supply reduces lignin degradation, while N limitation stimulates preferential/selective ligninolysis. For the brown-rot basidiomycete no additional assumptions were made.

The limited N in wood does not allow extensive polysaccharide degradation neither by the white-rot nor the brown-rot fungus. On the other hand, it promotes lignin **degradation** in white-rot and lignin **modification** in brown-rot. By degrading/modifying lignin white- and brown-rot fungi, mobilize lignin-bound N and their intracellular N pool increases, also making accessible the non-lignin-bound N portion of the cell walls. Growth and fruit body formation once more reestablishes N limitation.

In the case of white-rot fungi increased N pool levels transiently repress ligninolitic activity. We think that local variations in the N distribution within wood of one tree, or otherwise differences in the N content of wood species, may individually modulate the proportion of lignin vs polysaccharide degradation. Thus, the lower the N content is, the more selectively should lignin be degraded, while a higher N content should promote a simultaneous degradation of all wood components or even lead to a preferential polysaccharide breackdown. This is supported by results recently published (Dill and Kraepelin [1986]).

In the case of brown-rot fungi it is still unclear if the N concentration of wood also plays a comparable role in the process of lignin modification (less methoxyl and more α-carbonyl groups, increased solubility in organic solvents).

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Besides any regulatory function of N, we suggest that brown-rot species satisfy their N requirement for growth by mobilizing the lignin-bound N portion through a specific modification of the half remaining lignin.

EXPERIMENTAL RESULTS AND DISCUSSION

Brown-rot decay

For laboratory culture series birchwood blocks infected with the brow-rot fungus *Piptoporus betulinus* and incubated at 20°C were used. Chemical analysis showed that with increasing weight loss the content of H_2SO_4 insoluble lignin (Klason lignin) increased. As expected, the N concentration of the wood also increased, but remarkably the N concentraion in the Klason lignin fraction significally dropped below the value of corresponding sound wood. Already at stages of 14% weight loss about 30-40% of the lignin-bound N portion became mobilized by fungus, The same phenomenon was observed in several field samples.

White-rot decay

In contrast the brown-rot decay by *Piptoporus betulinus.*, the analytical results obtained from white-rot samples degraded by *Phanarochaete chrysosporium* and *Fomes fomentarius* respectively in no one case gave reduced values for the N content in the Klason lignin fraction. By lignin degradation the portion of lignin-bound (originally about 50% of total N in sound wood) simultaneously decreased. This indicates that by degrading lignin the fungus sets free N which can supply its own demand.

In samples showing highly selective lignin degradation an increased N concentration in the the Klason lignin fraction was found. This secondary N enrichment may be explained either by contaminating mycelium or by a really higher N concentration in the residual lignin portion in the degraded cell walls.

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Publication nº 121
May 2000
reprint
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