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BIODESTRUCTION OF LIGNINS BY THE BASIDIOMYCETE *Pleurotus ostreatus*

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*The depolymerization, demethoxylation, and oxidation of lignin by the common oyster mushroom (*Pleurotus ostreatus*) is demonstrated.*

Key words: basidiomycete, *Pleurotus ostreatus*, lignin-containing raw material, demethoxylation.

The enzyme complex of higher basidiomycetes, the wood-destroying fungi, contains enzymes that can decompose polysaccharides, lignin, and other biopolymers [1]. Owing to this capability, basidiomycetes play an important role in the biodestruction of lignocellulose wastes in nature and can be used to solve many problems in biotechnology.

We screened new strains of basidiomycetes that utilize cellulose and lignin for growth [2]. As a result, active stains for destroying plant lignin, cellulose, and polysaccharides were identified from 264 fungal cultures. The most active producers of cellulase, hemicellulase, and ligninase were the basidiomycetes *Pleurotus ostreatus* and *Panus tigrinus* [2-4].

The present article presents results from a study of the effect of *Pleurotus ostreatus* on lignocellulose raw material (cotton stem, ambary fiber, rice husk, cotton pulp), industrial lignins (hydrolyzed lignin of cotton seed husk, HLCSH; hydrolyzed lignin of rice husk, HLRH) and dioxanelignin of ambary fiber (DLAF).

The lignin component of these samples is split into known low-molecular-weight phenolic compounds during biodestruction of lignocellulose raw material by the enzyme complex of *Pleurotus ostreatus* (Table 1). Substances with the *p*-coumaric structure dominate among the destruction products. This agrees with the literature, which indicates that white-rot fungi, in particular, basidiomycetes, depolymerize lignin to form demethoxylated low-molecular-weight products [5, 6].

The pH value of the medium was neutralized from 1.6-2.2 to 4.5-5.2 during the growth of *Pleurotus ostreatus* on industrial lignins HLCSH and HLRH. The content of readily (RHPS) and difficultly hydrolyzed polysaccharides (DHPS) increased (Table 2). Incubation of *Pleurotus ostreatus* for 7 d (168 h) on HLCSH and HLRH produced to noticeable changes in their functional composition.

Therefore, the decrease in the amount of methoxyls indicates that *Pleurotus ostreatus* causes demethoxylation. The reduction of the mass fraction of C and H indicates that lignin macromolecules are destroyed. Hydrolyzed lignin is known to contain a certain amount of cellulose. Therefore, the increased contents of RHPS and DHPS may be a result of the destruction of this residual cellulose.

Dioxanelignins are the closest preparations to natural (unisolated) lignins [7]. Therefore, it seemed interesting to study the biodestruction of dioxanelignins of one of the samples in order to confirm that *Pleurotus ostreatus* causes demethoxylation and other reactions.

The elemental and functional composition of dioxanelignin of ambary fiber (DLAF) is changed by the enzyme complex of *Pleurotus ostreatus* as a function of the duration of the treatment. Table 3 shows that the biodestruction of DLAF is accompanied by an increase in the mass fraction of oxygen, which is consistent with the oxidation of lignin, whereas the reduction in the amount of methoxyls confirms that the enzyme complex of *Pleurotus ostreatus* causes demethoxylation. The reduction in the amount of carbonyls and hydroxyls indicates that incubating the fungus with DLAF can cleave the ester bonds and propane sidechains of lignin.

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TABLE 1. GLC of Total Phenolic Substances from Fermented Lignocelluloses (% in Mixture)

Substance	Cotton stems	Ambary fiber	Rice husk	Cotton pulp
Vanillin	3.61	4.17	1.35	4.07
p-Hydroxybenzaldehyde	41.57	34.44	38.46	58.78
p-Hydroxybenzoic acid	0.40	9.72	4.60	-
Vanillic acid	3.01	1.39	1.65	2.54
p-Hydroxyacetophenone	0.40	-	2.45	3.05
Acetovanillone	3.61	13.89	2.70	6.11
Syringaldehyde	-	6.94	-	1.27
Syringic acid	20.48	19.44	11.50	24.17
Unident.	22.0	10.0	6.25	3.0

TABLE 2. Composition Change of Industrial Lignins Caused by *Pleurotus ostreatus*

Components, %	HLCSH		HLRH	
	before incubation	after incubation	before incubation	after incubation
DHPS	0.18	2.12	0.25	3.17
RHPS	0.62	7.31	0.81	11.08
C	54.5	52.15	58.90	55.80
H	6.57	4.79	6.93	4.88
OCH_3	5.40	4.32	7.80	5.78
COOH	0.08	0.10	-	-

TABLE 3. Change of Elemental and Functional Composition of DLAF Caused by *Pleurotus ostreatus* Enzyme Complex, %

Time, h	C	H	O	CO	OCH_3	OH_{tot}	OH_{phen}
0	69.50	6.57	33.93	6.17	24.35	16.41	14.48
10	62.14	6.09	31.77	5.93	16.80	11.33	11.60
20	61.07	5.68	33.25	5.67	12.40	9.91	9.87
30	58.03	4.79	37.18	4.82	10.97	7.69	6.77

Thus, the study of the effect of *Pleurotus ostreatus* on lignin-containing raw material showed that its enzyme complex cleaves polysaccharides and causes depolymerization, demethoxylation, and oxidation. This was confirmed by studying the effect of the enzyme complex of *Pleurotus ostreatus* on dioxanelignin isolated from ambary fiber [8].

EXPERIMENTAL

A local strain of *Pleurotus ostreatus*, UzBI-T105 was used. The enzyme complex was obtained from the selected strain UzBI-ZaKh 105/7.

Raw-material preparation. HLCSH and HLRH were washed with distilled water to remove residual H_2SO_4, dried at room temperature, and used in further studies. Cotton stems, ambary fiber, rice husk, and cotton pulp were defatted beforehand by alcohol—benzene extraction according to the literature [9].

The DHPS and RHPS contents were determined by an ebulliostatic method [9]; the content of functional groups, by the literature method [9]. GLC of the total phenolic substances used the literature method [8].

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